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Heavy 4-8-4 Locomotives For the Northern Pacific

Passenger power has 77-in. drivers and develops 69,800 lb. tractive force. The firebox, for lignite coal, has 115 sq. ft. of grate area. All driving journals have Timken roller bearings

TEN passenger locomotives of the 4-8-4 type have been delivered to the Northern Pacific by the Baldwin Locomotive Works. These locomotives, which are the second order of this type to be purchased by the road, are among the heaviest and most powerful of the type yet built and the 77-in. driving wheels are one inch larger than the largest previously employed on locomotives of this type. With cylinders 28 in. by 31 in. and a boiler pressure of 260 lb., these locomotives develop a rated tractive force, with 70 per cent maximum cut-off, of 69,800 lb. All the driving-axle journals are fitted with Timken roller bearings.

The locomotives of the first order, particulars of which are included in the table of comparisons with other 4-8-4 type locomotives, develop 57,500 lb. tractive force and have driving wheels 73 in. in diameter.

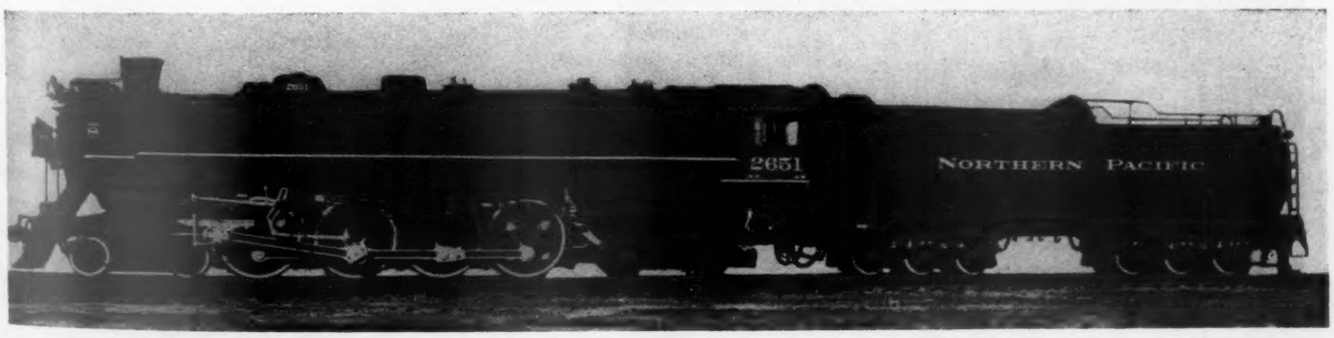
A prominent feature of the proportions of these locomotives is the firebox which has a grate area of 115 sq. ft. As in the case of other locomotives built for the Northern Pacific during the past six years, this is occasioned by the extensive use of Rosebud lignite coal in locomotive service. The heating value of this fuel is about 8,700 B.t.u per pound. It has a moisture content of over 20 per cent and runs under 8 per cent in ash.

The Boiler

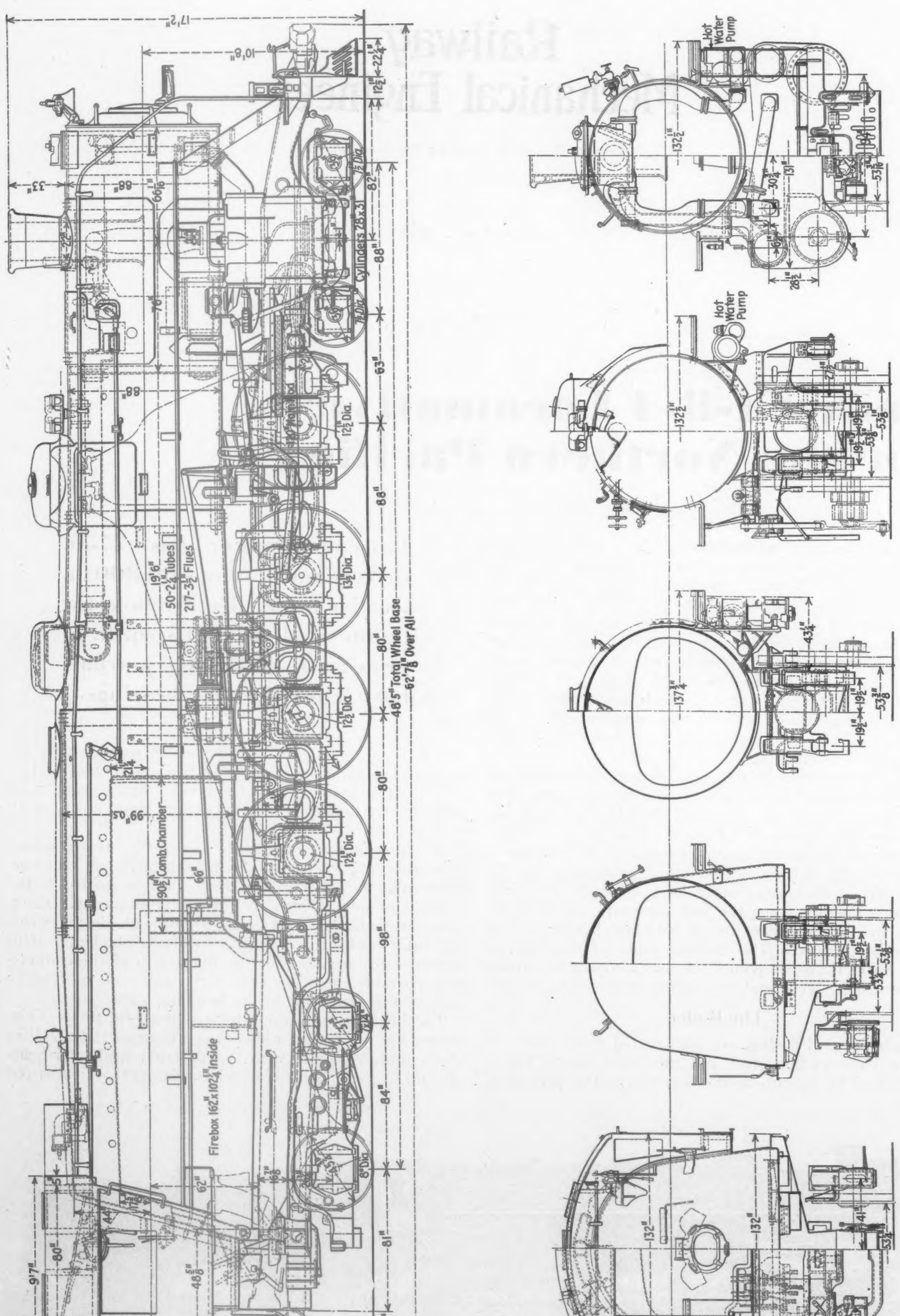
The boiler and firebox are constructed from plates of Lukens basic carbon steel and the boiler barrel has a diameter of 88 in. outside the first ring. The firebox is 162 in. long by 102¼ in. wide, which provides a grate area of 115 sq. ft. and a ratio to heating surface of 1 to 43.16. The combustion chamber is 90 in. long, thus bringing the length of the tubes and flues down to 19 ft. 6 in.

Welding is used extensively to seal the firebox seams. The back tube sheet is welded, both inside and outside, after calking. The firebox door sheet is welded to the crown and sides, which are formed from a single sheet. The outside throat sheet is also sealed with electric welding after calking. Flannery Telltale staybolts, with welded caps, are used for the full length of the combustion chamber, for the first three rows of roof stays back of the seam and in the breaking zone.

The brick arch is supported on five 4-in. tubes. The boilers are fitted with Elesco Type E superheaters. Five of them are equipped with Worthington feedwater heaters and five with Wilson water conditioners. Coal is fed



Northern Pacific 4-8-4 type, Class A-2, heavy passenger locomotive



Elevation and cross sections of the 4-8-4 type locomotive built by the Baldwin Locomotive Works for the Northern Pacific

by a modified Type B du Pont-Simplex stoker with a capacity of 25,000 lb. of coal per hour. The front end is fitted with a Cyclone spark arrester.

Separate turrets are provided for superheated and saturated steam. The superheated-steam turret in the smokebox provides for the blower, air pumps, whistle, headlight turbo-generator and the stoker. The saturated steam turret in the cab provides steam for the injector, the feedwater heater, the power reverse gear, lubricator heaters, drifting valves, steam heat in the cab and train, and the coal pusher. The boiler has no auxiliary dome; the safety valves are screwed directly into the third boiler course back of the main dome. The whistle is mounted alongside the smokebox. The boilers are fitted with Wilson sludge-removers and air-operated blow-off cocks.

Foundation and Running Gear

The locomotive is built on the General Steel Castings Corporation bed, with which are cast the cylinders, including the back heads, the air reservoirs and the inside cradle. A unique feature of the cylinders, shown on the drawings, is the extension of the saddle flange high up on each side of the smoke arch, and the inclusion of the outside steam pipe connection as a part of the saddle. The lower ends of the branch pipes are directly connected to the saddle passages to the steam chests in pockets in the casting which open directly into the smokebox. Thus, the troublesome gland-packed openings through the smokebox are entirely dispensed with.

The 70-in. driving-wheel centers are of the General Steel Castings Corporation Boxpok design, which were cast of Vanadium steel by the Standard Steel Works Company. The advantage of the disk design in a wheel center of such large diameter lies in securing a better casting than with the conventional spoke design. The main wheels of the locomotive are cross-counter-balanced according to the A.R.A. method. One locomotive is fitted with the Prendergast interlocking spring rigging.

All driving axles are fitted with Timken roller bearings. These are provided with safety bombs—chemical cartridges inserted in the bearing housings—which warn against overheating by giving off visible fumes before bearing temperatures have reached a dangerous point. The Alco lateral motion device is applied to the front driving box, giving a lateral of 1 in. on each side between the boxes and pedestals. This reduces the rigid wheel base to 13 ft. 4 in. The other driving boxes are all fitted with 3/8-in. total lateral play.

The connecting rods are of annealed, open-hearth steel with solid ends. The front end of the main rod is fitted with a solid brass bushing pressed in. The back end of the main rod and the side rods are all fitted with fixed bushings of Hunt Spiller gun iron, pressed in, and with floating bushings of brass.

The engine truck is of the four-wheel, center-bearing, General Steel Castings constant-resistance type, with a one-piece cast-steel frame. The wheels are rolled steel, 36 in. in diameter, and are mounted on axles with Timken roller bearings in inside journal boxes. The trailer truck is the four-wheel Delta constant-resistance type with a one-piece cast-steel frame. The front axle is fitted with American Steel Foundries roller-bearing unit with Timken centering device on the box and 37-in. rolled-steel wheels. The rear axle has Timken roller bearings in outside boxes and 45¾-in. steel tired wheels. All axles and crank pins are of open-hearth carbon steel, normalized and tempered. The locomotive axles are hollow bored, as are also the main crank pins.

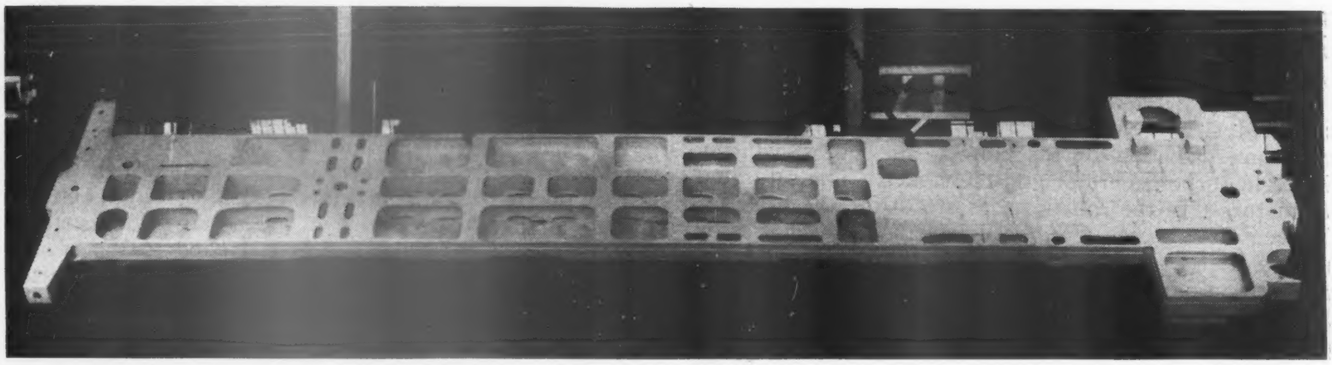
The 14-in. piston valves are driven by a Walschaert

Comparison Table of Some Recent 4-8-4 Type Locomotives

Road	Nor. Pac.	Nor. Pac.	Grt. Nor.	C.B.&Q.	C.&N.W.	C.M.St.P.&P.	C.R.I.&P.	Sou.Pac.	Wabash	St.L.-S.W.
Builder	Bald.	Amer.	Bald.	Bald.	Bald.	Bald.	Amer.	Bald.	Bald.	Bald.
Road Class or No.	A-2	A-1	S-2	0-5	H	S-1	5,027	GS-1	O-1	L-1
Tractive force, lb.	69,800	57,500	58,300	67,500	65,200	60,000	66,000	60,000	70,817	61,500
Weight of engine, lb.	489,400	426,000	420,900	454,590	498,000	450,838	436,000	442,300	454,090	422,500
Weight on drivers, lb.	279,800	260,000	247,300	271,680	288,000	258,814	266,500	262,000	274,100	242,500
Cylinders, in.	28 x 31	28 x 30	29 x 29	28 x 30	27 x 32	28 x 30	26 x 32	27 x 30	27 x 32	26 x 30
Drivers, diam. in.	77	73	80	74	76	74	69	73½	70	70
Steam pressure, lb.	260	210	225	250	250	230	250	250	250	250
Heat. surface, firebox, total, sq. ft.	542.8	485	379	439	558	540	515	356	495	469
Heat. surface, tubes and flues, sq. ft.	4,421.5	4,115	4,402	4,878	4,656	4,860	4,928	4,500	4,689	4,259
Tube length, ft.-in.	19-6	21-0	22-0	21-0	21-0	21-0	21-6	21-6	21-0	20-0
Superheat. surface, sq. ft.	2,174	1,992	2,265	2,403	2,357	2,403	2,243	2,565	2,360	2,060
Grate area, sq. ft.	115	115	97.7	106.5	100	103	88.3	90.4	96.2	88.3
Superheater	E	E	E	E	E	E	E	E	E	E
Feedwater heater	Worth.	Exh. inj.	Exh. inj.	Elesco	Worth.	Worth.	Worth.	Worth.	Worth.	Worth.
Booster	No	Yes	No	No	Yes	No	Yes	Yes	No	No

Note 1:—Northern Pacific Class A-1 was built in 1927; Chicago & North Western in 1929; others in 1930 or later.
Note 2:—Tractive force is for main cylinders only and does not include booster.

Commonwealth locomotive bed for Northern Pacific 4-8-4 type locomotives which includes frames, rear cradle, cylinders with back heads and main reservoirs, and weighs 79,000 lb. complete with pedestals



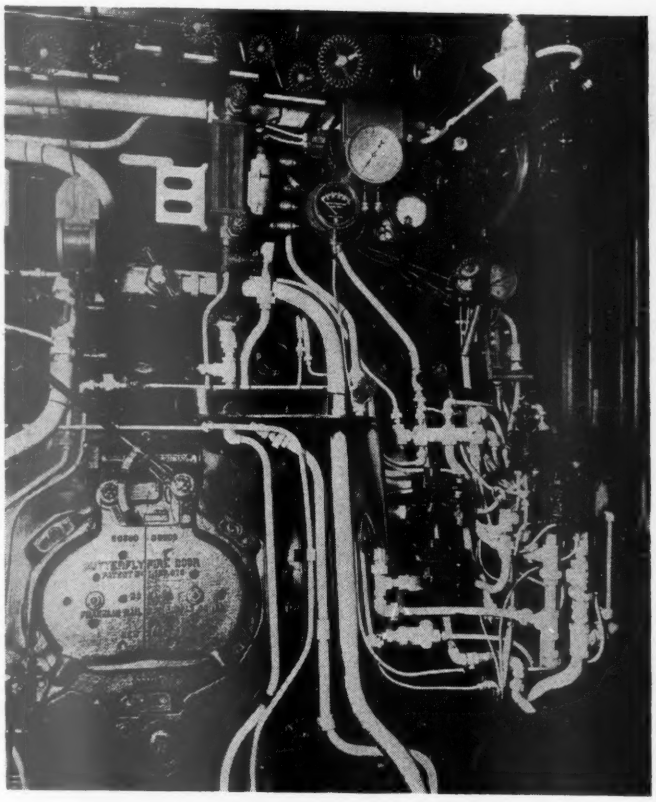
The Commonwealth cast-steel water-bottom tender frame weighs 31,800 lb.

valve gear with a maximum travel of 7½ in. and designed for a limited maximum cut-off of 70 per cent, controlled by an Alco power reverse gear. The locomotive is also equipped with an Alco power-operated throttle lever with provision for auxiliary manual operation, and with the American multiple type throttle. The dry pipe is fitted with the Tangential steam dryer and shut-off valve.

The tender has a General Steel Castings water-bottom underframe with a modified Vanderbilt type tank of welded construction. The water capacity is 20,000 gallons and fuel space is provided for 27 tons. The tender is carried on two General Steel Castings six-wheel trucks. The truck wheels are 37 in. in diameter and the axles are fitted with American Steel Foundries roller-bearing units. The tenders are equipped with track sprinklers.

Special Equipment Applied on Northern Pacific 4-8-4 Type Locomotives

Railroad	Northern Pacific
Builder	Baldwin Locomotive Wks.
Road class	A-2
Road numbers	4650—4659
Boiler:	
Boiler and firebox steel	Lukens
Staybolts	Ulster Special
Flexible staybolts	Flannery
Button-head radials (12 rows center of crown)	Agathon Nickel Iron
Brick arch	American—Security
Smokebox door hinges	Okadee
Spark arrester	Loco. Firebox—Cyclone
Blower nozzles	TZ
Smokebox blower fitting	Barco
Superheater	Elesco Type E
Throttle	American—Multiple
Steam dryer and shut-off valve	Tangential
Lagging	Johns-Manville
Feedwater heater (5)	Worthington
Water conditioner (5)	Wilson
Inspirator (1,000 gal.)	Hancock—K.N.L.
Boiler checks	Hancock
Blow-off cocks (air operated)	Wilson—N.C.
Sludge remover	Wilson
Washout plugs	TZ
Stoker	Standard—Modified du Pont-Simplex
Firedoor	Franklin—Butterfly No. 8
Grates (1 engine)	Firebar
Cabs, fittings, boiler mountings:	
Safety valves	Consolidated
Pressure gages	Ashton—Double dial
Back-pressure gage	Ashton—Duplex (with pulsation retarding device)
Speed indicator	Weston Electric
Water column	Edna
Drainpipe receptacles through cab floor	TZ
Low-water alarm	Barco
Valves, globe	Crane
Valves, globe on stoker	Hancock
Car heating equipment	Vapor Car Htg.
Whistle	Hancock chime
Whistle operator	Viloco
Bell ringer	U. S. Metallic Pack.—King No. 33
Sander	Graham-White
Track sprinkler valve (tender)	Walworth
Headlight generator (5)	Pyle-National
Headlight generator (5)	Sunbeam
Marker lamps	Adams & Weatlake—Cast aluminum
Back-up lamps	Pyle-National
Power throttle lever	Alco
Clear-vision windows	Prime
Cab seats	Gustin-Bacon (with Mc-Entire spring seat cushion)
Running boards	Irving Iron Wks.—Safkar
Running-board steps	Visabledge Safstep
Cylinders and driving gear:	
Limited cut-off	Franklin
Bushings	Hunt-Spiller Gun Iron
Piston-packing rings	Hunt-Spiller—Duplex
Piston-rod and valve-stem packing (5)	U. S. Metallic Pac.—King type
Piston-rod and valve-stem packing (5)	Crescent—King type
Rod brasses	National Bearing Metals.—Arctic
Crosshead and wrist pin	Union Steel Casting.—Hubbard
Connecting-rod bushings	Hunt-Spiller Gun Iron
Power reverse gear	Alco Type G
Drifting valve	Crane, Chronometer type
Cylinder cocks	Okadee Automatic
Frames and running gear:	
Locomotive bed	General Steel Castings
Pilot beam	General Steel Castings
Driving-wheel centers	Boxpok
Driving-axle bearings	Timken
Lateral motion device	Alco
Springs	American Steel Foundries
Interlocking spring rigging (1)	Prendergast
Truck, engine, 4-wheel	General Steel Castings—Center bearing, constant resistance
Truck, trailer, 4-wheel Delta	General Steel Castings
Wheels, engine truck	Standard Steel Wks.—Rolled steel
Wheels, front axle trailer truck	Standard Steel Wks.—Rolled Steel
Wheels, rear axle trailer truck, steel tired, Hy-lastic Vanadium steel center	Standard Steel Wks.
Centering device, front trailer axle boxes	Timken
Engine-truck bearings	Timken (inside)
Trailer truck, front axle bearing	American Steel Foundries, Roller
Trailer truck, rear axle bearing	Timken (outside)
Pilot	General Steel Castings
Radial buffer	Type D
Couplers	National Malleable & Steel Castings
Coupler release rigging	Imperial
Draft gear	Miner A-94-X-B
Lock nuts	Grip Nut
Lubrication:	
Mechanical lubricator	Nathan—DV3
Hydrostatic lubricator (Air pump, stoker and feedwater pump)	Detroit 4-feed (one feed blanked)
Piston and rod grease lubricator	Viloco
Pin and valve motion	Alemite
Guide oil cups	Hancock
Flange lubricator	Imperial
Brakes:	
On drivers, engine truck and trailer	American
Operating brake	6ET
Air compressors	2—8½-in. cross-compound
Tender:	
Frame, water bottom	General Steel Castings
Trucks, 6-wheel	General Steel Castings
Truck axle bearings (37-in. wheels)	American Steel Foundries—Roller
Journal boxes (6½ in. by 12 in.)	National Malleable & Steel Castings
Dust guards	Butler Railway Supply—Pro-tec-to
Truck side bearings	Stucki
Truck brakes	American Steel Foundries—Simplex Clasp
Coal pusher	Standard Stoker—Type DA
Flexible connections, engine and tender	Barco
Tank hose coupler	TZ
Tank valves	TZ
Coupler	National Malleable & Steel Castings
Paint (tender)	Duco



Right side of back boiler head

The locomotives are equipped with the No. 6 ET brake applied to all driving, truck and tender wheels. Two 8½-in. cross-compound compressors are mounted on the left side of the boiler. Five of the locomotives have Pyle-National, and five Sunbeam turbo generators. Other accessories include the Franklin Butterfly fire door, Barco low-water alarm and a Hancock non-lifting inspirator of 10,000 gallons capacity.

These locomotives were designed for use in heavy through passenger service and for handling silk specials in continuous runs between Jamestown, N. D., and Missoula, Mont. The 904 miles of line between these points includes sections of rolling grade, water level grades, and heavy mountain grades. They will replace the 12 lighter 4-8-4 type locomotives of the first order, which have been assigned to other districts. The first of the locomotives, which was turned out of the Eddystone plant of the Baldwin Locomotive Works in September, was on exhibition at the Wings of a Century Pageant at the Century of Progress Exposition at Chicago from September 15 to October 5 before proceeding to its home rails.

The principal data and dimensions are given in one of the tables.

Table of Dimensions, Weights and Proportions of the Northern Pacific 4-8-4 Type Locomotives

Railroad	Northern Pacific
Builder	Baldwin Locomotive Works
Road class	A-2
Type of locomotive	4-8-4
Service	Passenger
Cylinders, diameter and stroke	28 in. by 31 in.
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	7½ in.
Crank throw	19½ in.
Steam lap	1 15/16 in.
Exhaust clearance	⅜ in.
Lead, constant	¼ in.
Cut-off in full gear, per cent	70
Weights in working order:	
Total engine	489,400 lb.
On drivers	279,800 lb.
On front truck	96,600 lb.
On trailing truck	113,000 lb.
Tender	387,600 lb.
Wheel bases:	
Driving	20 ft. 8 in.
Rigid	13 ft. 4 in.
Engine total	48 ft. 5 in.
Engine and tender, total	95 ft. 3 in.
Wheels, diameter outside tires:	
Driving	77 in.
Front truck	36 in.
Trailing truck	37 in. and 45¾ in.
Journals, diameter and length:	
Driving, main	13½ in.
Driving, others	12½ in.
Front truck	7½ in.
Trailing truck	7 in. and 8 in.
Boiler:	
Type	Conical
Steam pressure	260 lb.
Fuel, kind	Rosebud coal
Diameter, first ring, outside	88 in.
Firebox, length and width	162 in. by 102¼ in.
Height mud ring to crown sheet, back	79⅝ in.
Height mud ring to crown sheet, front	87¼ in.
Arch tubes, number and diameter	5—4 in.
Combustion chamber length	90½ in.
Tubes, number and diameter	50—2¼ in.
Flues, number and diameter	217—3½ in.
Length over tube sheets	19 ft. 6 in.
Grate area	115 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	480.2 sq. ft.
Arch tubes	62.6 sq. ft.
Firebox, total	542.8 sq. ft.
Tubes and flues	4,421.5 sq. ft.
Total evaporative	4,964.3 sq. ft.
Superheating	2.174.0 sq. ft.
Comb. evap. and superheat	7,138.3 sq. ft.
Special Equipment:	
Brick arch	Yes
Superheat	Elesco Type E
Feedwater heater (5)	Worthington 6-S-A
Feedwater conditioner (5)	Wilson
Stoker	Duplex-Simplex Type B modified
Tender:	
Style	Vanderbilt W.B.
Water capacity	20,000 gal.
Fuel capacity	27 tons
General Data, estimated:	
Rated tractive force (70 per cent cut-off)	69,800 lb.
Potential horsepower (Cook)	4,000 hp.
Speed at 1,000 ft. piston speed	44.45 m.p.h.
Piston speed at 10 m.p.h.	225.6 ft.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	57.2
Weight on drivers ÷ tractive force	4.0
Weight engine ÷ potential hp.	122.3
Weight engine ÷ comb. heat. surface	68.6
Boiler proportions:	
Tractive force ÷ comb. heat. surface	9.8
Tractive force x dia. drivers ÷ comb. heat. surface	753.0
Comb. heat. surface ÷ grate area	62.1
Comb. heat. surface ÷ potential hp.	1.78
Potential hp. ÷ grate area	34.8
Firebox heat. surface ÷ grate area	4.72
Firebox heat. surface, per cent of evap. heat. surface	10.95
Superheat. surface, per cent of comb. heat. surface	30.5

* * *

"Invicta"—Built by Stephenson in 1880 for the Canterbury & Whitstable, the second English railway for public use to employ a steam locomotive. Wheels, 4 ft. diameter; cylinders 10½ in. by 18 in. Now preserved at Canterbury (a few slight changes have evidently been made since originally built.)

Determining Car-Wheel Eccentricity

By W. E. Gray*

Part I—Lack of rotundity and concentricity of car wheels seriously affects riding qualities—New gages developed for accurate testing

THE evil effects of eccentric and out-of round wheels under passenger and freight cars are becoming more and more clearly recognized every day. Patrons of transportation are rapidly becoming more critical of bad riding qualities in railway passenger cars, some of which may be chargeable to the condition of the wheels. Availability of trucks for freight hauls makes it no longer possible to hold business in the face of dissatisfaction with shipments delivered in damaged condition, even though damage claims are paid, and this same truck competition is also forcing higher and higher freight train speeds which is making more and more pressing the question of riding qualities of freight cars. No detail, however seemingly small, can afford to be overlooked in the battle to retain the railroads as the nation's basic purveyor of transportation. Railway cars in motion are subjected to periodic vertical displacements by wheels the treads of which are not true with the journals of the axles. At certain speeds the frequency of these disturbances synchronizes with the natural period of the springs on the car and oscillations are caused which may be violent enough to be very uncomfortable to passengers or to damage fragile lading. The remedy lies in eliminating the cause of this disturbance by having the wheels as true as possible. There are other factors which also produce synchronous oscillations but they are not considered in this article.

Wheels have been under close scrutiny for a number of years as regards roundness and concentricity, but the subject reminds one of Mark Twain's comment about the weather, "There is more said and less done about it than any other thing of which he knew." Perhaps one reason that so little progress has been made in the matter of improving the condition of wheels is because so many difficulties have been encountered in measuring mounted wheels to tell just how true they are. These difficulties apply to new wheels as well as to wheels that are installed under cars. In the large majority of cases the roundness of new wheels is essentially a question of manufacture; concentricity is a question of wheel shop practice, and unless close work is done in both factory and wheel shop mounted wheels will not be as true as it is possible to make them. The manufacturer is equipped with ring gages which have proven satisfactory for determining the roundness of wheels but the wheel shop has not had any such satisfactory device for checking its part of the work of preparation of the wheels for service, and the repair yards have been woefully lacking in equipment for determining the condition of worn wheels.

Offhand it might seem to be a fairly simple task to tell quickly how round and concentrically mounted a pair of wheels are, but a little reflection will show that it is not such a simple job as it seems. If it is a question of a pair of wheels that are under a car the problem is much more complicated. For this situation the A.A.R. has recently recommended a gage that is made in the form of a circular arc 12 in. long. This gage is applied to the tread of the wheel and if there is not more than 1/16 in. space between the gage and the tread at any point in the 12 in. the wheel is presumed to be satisfactory. It is almost obvious that the information gained by using such a gage is useless, because in the attempt to provide a usable gage the correct principle of measurement was submerged. Eccentric mounting can be productive of bad riding qualities just as well as wheels being out of round, and this gage cannot give any information on that point. The limit of 1/16 in. in 12 in. is also rather questionable, as this seems to be large enough to cause serious disturbance to car riding.

Table I is presented to show the actual condition of four pairs of used cast iron wheels which had been passed as serviceable by this gage and were later measured by another method. The measurements given are the differences in radial distance between journal surface

* Engineering Experiment Station, Purdue University, Lafayette, Ind.

Table I—Eccentricity Measurements of four Pairs of Cast-Iron Wheels not Condemnable with the A. A. R. 12-in. Arc Gage*

Mark No.	Pair No. 1		Pair No. 2		Pair No. 3		Pair No. 4	
	Left	Right	Left	Right	Left	Right	Left	Right
1	.115	.000	.000	.010	.000	.070	.000 1.3–.010 1.8–.000	.012
2	.061	.040	.052	.000	.110 2.6–.155	.065 2.5–.072	.018	.078
3	.035	.077	.113	.003	.128 3.2–.123	.038 3.6–.000	.077	.156
4	.015	.092	.132	.043	.182 4.2–.192	.014 4.2–.003	.155	.192
5	.000	.113	.129	.091 5.4–.105	.168 5.5–.193	.035 5.9–.071	.181 5.1–.189	.159
6	.064	.122	.084	.098	.180 6.4–.134	.065 6.3–.060	.168	.087
7	.118	.095	.016 7.8–.032	.077	.145 7.8–.087	.082 7.5–.071	.110	.009 7.1–.002 7.8–.017
8	.130	.046	.020	.041	.098 8.2–.101	.087 8.6–.061	.035	.000 8.5–.023

* All measurements are in inches above the minimum radial distance from journal surface to wheel tread.

and wheel tread at the reference marks as noted, the minimum radial distance being called zero. Eight of these reference marks are equally spaced around the circumference of the wheel. They are numbered from 1 to 8 and corresponding marks on the two wheels of a pair are in line. Where the tread changes direction of its trend between two adjacent marks the position of maximum or minimum reading is given by a decimal fraction.

The information presented in Table I is sufficient to show that useful data cannot be obtained with this type of gage. These wheels were later installed under a freight car and a riding qualities test made which showed violent bouncing at speeds between 25 and 30 m.p.h. which was not present when the car was equipped with true wheels.

When the wheels are not under a car the problem of measuring their condition is not quite so difficult, but it is still far from being a simple task in order to secure the necessary accuracy. One of the illustrations shows a gage for this purpose which is based on the correct principle, since it is designed to check the radial distance from the journal to the wheel tread. In order that the car be not subjected to vertical movements by the wheels as they revolve it is necessary that this radial measurement does not vary at different points around the circumference. The proper measurement is from the journal through the center of the axle to the point on the wheel tread diametrically opposite, as these two points are the ones in engagement between the car and the track at any one time, but if the journals are round, as they should be, there will be no error introduced by measuring from the journal to the tread on the same side of the journal. The main difficulty with this gage is that in the interests of making it light and portable it has suffered in dependability and accuracy. The base for contact on the journal is too small for any great reliability and the accuracy of measurement that can be secured is not very great. With wheels that are absolutely round this gage might be used to check eccentricity within 1/32 in. but if the wheels are not truly round then it is a rather hopeless task to obtain an accurate record of their condition with this gage.

Wheel concentricity gage—This type of gage not satisfactory for accurate work

The one reliable method of checking wheel conditions that has been in use is to swing them on the axle centers in a lathe. While this method gives reliable results there are certain other considerations which make it more or less impractical. The wheels have to be removed from the car and transported to the wheel shop. A great many wheel shops are not equipped with lathes large enough to swing a pair of mounted wheels, this being particularly true of shops where cast iron wheels alone are handled. Standard equipment in such shops includes only an axle lathe. Since there are so many more cast iron wheels used than all other kinds put together it will be appreciated that many wheel shops cannot check mounted wheels in lathes even if they wanted to go to the trouble of taking them from under the cars and sending them to the shop.

From the foregoing discussion it will be apparent that it is not entirely a lack of interest in the problem that is responsible for there not having been more progress made in the matter of properly mounting new wheels and removing from service wheels that have worn so badly out of true that they should be replaced. A great many cast iron wheel shops may be putting out wheels that are not as perfectly mounted as they might be, but this is because they have no way of checking the wheels to know what results are attained.

In Table II are shown tread eccentricity conditions for four pairs of new cast iron wheels as they came from a wheel shop, these being representative of the output of this shop at the time the check was made. The foreman of this shop had no idea that the wheels he was turning out were not as perfect as they might be because he had no way of accurately measuring his work. When this condition was discovered he immediately made an improvement in the quality of his output by carefully checking up his boring mill and making slight adjustments. It should be evident that there is plenty of room for improvement in gages and methods of measuring wheels for trueness, and it is the purpose of this article to describe some devices recently developed for that purpose with the idea of securing their more general use.

The question arises as to what accuracy is possible in the matter of wheel trueness, and the answer is that it depends to a large extent on the kind of wheels and the methods of preparation used. There are two factors involved in wheel trueness—rotundity and concentricity. A wheel may be round in every sense of the limitations implied by that word and still not be true with the journal because it was bored eccentrically and not trued up after being mounted. If a wheel is not round it cannot be true with the journal because it has no center which is equidistant from every point around the tread. For a pair of wheels to be perfect it is necessary that they not only be absolutely round but that they be mounted on axles having round journals in such a way that the centers of the wheels and of the journals coincide. Obviously these conditions cannot be attained by hit and miss methods, and it is almost as obvious that it is hardly justifiable from an economic standpoint to strive for absolute perfection for every pair of wheels mounted. It is necessary to adopt the happy medium which will bring the largest return on the money invested, and this happy medium depends upon the kind of wheels used, as methods of preparation differ with different kinds of wheels.

Three kinds of wheels are in use on the railroads of this country, cast iron, cast steel and wrought steel. More than ninety per cent of the wheels used are cast iron. These have a hard chilled tread which cannot be machined by any method except grinding, and they are expected to be used without having the tread trued up after mounting. However, a few roads grind the treads of these wheels when they are first mounted in order to true them up with the journals, and a larger number of roads grind flat spots out of used cast iron wheels in order to restore them to a serviceable condition. The amount of material which can be removed from the tread of a cast iron wheel and still leave it useful is limited because the chilled portion of the tread is only about ¾ in. deep when the wheel is new and there must be an appreciable amount of this material left or the wheel will not stand up in service. By far the greater part of cast iron wheels are mounted and used with the treads in the unmachined condition. Cast steel wheels are furnished by the manufacturer with a hardened tread that can only be machined by grinding, but in the process of manufacture the treads of these wheels are turned true before they are hardened. Ordinarily they will be round within very small limits, since the amount of warping that occurs during the heat treating operation after the treads are machined is very small. Wrought steel wheels have a tread which can be machined in a lathe, this tread being formed by rolling during the process of manufacture. A. A. R. specifications require that cast iron wheels from the manufacturer be sufficiently round so that when a truly round ring is used as a gage there shall not be more than $\frac{1}{32}$ in. space between the gage and the tread at any point on the circumference of the wheel. For wrought steel wheels this limit is $\frac{1}{16}$ in., but they are nearly always trued up in a lathe after they are mounted on the axles. There is no A. A. R. limit for rotundity on cast steel wheels, probably because of the manufacturing method producing wheels that are almost perfectly round.

From the preceding paragraph it will be seen that most of the problem of wheels not being round and true concerns cast iron wheels, both on account of the preponderance of their use and the limitations imposed upon them by manufacture. Since in the majority of cases the treads of these wheels are not machined, any out-of-roundness existing in the new wheel will show up in the mounted wheel. If the wheel is not bored concentric with the true circle which circumscribes its tread, eccentricity will be added to the out of-roundness and the resulting wheel when mounted will show great variation in the radial distance between tread and journal at different points around the circumference. It is necessary to permit some tolerance in locating the bore, say $\frac{1}{32}$ in., and when this is added to the $\frac{1}{32}$ in. out of round permitted for these wheels we have $\frac{1}{16}$ in. as the maximum variation in radial distance between journal and tread for mounted cast iron wheels that are not ground. In Table III are given the measurements for a representative lot of new cast iron wheels coming from the shop that had previously turned out the wheels listed in Table II. These latter wheels are representative of the work turned out after the boring mill had been adjusted as previously mentioned, and show that it is entirely possible to hold within a limit of $\frac{1}{16}$ in. for eccentricity on new cast iron wheels. [The details of the new type of wheel concentricity gage referred to, as well as a second gage for use in checking car wheels without the necessity of removing them from under the cars will be illustrated and described in a subsequent issue. —Editor.]

Table II—Eccentricity Measurements of four Pairs of New Cast-Iron Wheels—Boring Mill out of Adjustment*

Mark No.	Pair No. 1		Pair No. 2		Pair No. 3		Pair No. 4	
	Left	Right	Left	Right	Left	Right	Left	Right
1	.061	.069	.037	.013	.048	.007	.000	.040
	1.2–.079			1.7–.000		1.6–.000		1.2–.052
2	.072	.031	.000	.013	.000	.016	.007	.000
						2.9–.071		
3	.077	.011	.018	.030	.009	.067	.040	.011
			3.6–.057	3.6–.061				
4	.073	.004	.043	.054	.052	.051	.038	.050
		4.4–.000		4.7–.043				
5	.073	.006	.025	.054	.052	.043	.032	.068
				5.7–.071				
.6	.053	.017	.029	.060	.064	.058	.027	.089
		6.5–.029			6.6–.102			
7	.000	.020	.041	.083	.098	.029	.029	.098
			7.7–.022				7.9–.050	
8	.004	.057	.030	.053	.072	.025	.039	.070
			8.6–.058					

* All measurements are in inches above the minimum radial distance from journal surface to wheel tread.

Table III—Relatively Small Eccentricity of four Pairs of New Cast-Iron Wheels—Boring Mill Properly Adjusted*

Mark No.	Pair No. 1		Pair No. 2		Pair No. 3		Pair No. 4	
	Left	Right	Left	Right	Left	Right	Left	Right
1	.025	.023	.037	.012	.014	.017	.056	.000
			1.8–.043					
2	.016	.027	.036	.036	.012	.015	.038	.016
		2.3–.040		2.2–.044		2.3–.007		2.8–.042
3	.000	.031	.018	.026	.008	.021	.026	.037
				3.8–.000			3.4–.016	
4	.023	.021	.007	.005	.002	.011	.048	.037
	4.6–.025							
5	.007	.014	.000	.023	.013	.012	.021	.037
							5.8–.000	5.3–.057
6	.022	.027	.009	.044	.012	.005	.011	.037
					6.5–.000			
7	.009	.028	.032	.008	.009	.020	.031	.015
						7.7–.000		
8	.027	.006	.033	.014	.010	.009	.032	.030
		8.3–.000						

* All measurements are in inches above the minimum radial distance from journal surface to wheel tread.

Air-Conditioned Passenger Cars Placed in Service Since January 1, 1934

Railroad	No. of cars	Type of car	Date equipped	Type of system	Refrigerant	Manufacturer of system	Compressor drive	Generators: No.	Generators: Capacity, kw.	Generators: Type of drive	Generators: Type of mounting	Storage batteries: Make	Storage batteries: Amp.-hr. capacity[1]	Outside power supply: a. c. or d. c.	Outside power supply: Volts
Alton	4	Coaches	6-1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body	Exide	1,000	d. c.	32
	2	Obs.-lounge	6-1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body	Exide	1,000	d. c.	32
	2	Comb.	6-1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body	Exide	1,000	d. c.	32
A. C. L.	7	Diners	7-1934	St. eject.	Water	Safety C. H. & L.	......	1	7½	Flat belt	Body	Edison	600	....	....
A. T. & S. F.	4	Cafe-obs.	1934	St. eject.	Water	Safety C. H. & L.	......	1	7½	Flat belt	Truck	Exide	850	....	....
	8	Club	1934	St. eject.	Water	Safety C. H. & L.	......	1	7½	Flat belt	Truck	Exide	850	....	....
	14	Diners	1934	St. eject.	Water	Safety C. H. & L.	......	2	2—4 or 1—2.4 and 1—4	Flat belt	Truck	Exide	640—864	....	....
	10	Lounge	1934	St. eject.	Water	Safety C. H. & L.	......	1	7½	Flat belt	Truck	Exide	850	....	....
B. & M.	2	Comb.	6-1934	Ice	Ice	B. F. Sturtevant Co.	......	1	4	Flat belt	Body	Edison	298	....	....
	4	Coach	7-1934	Ice	Ice	B. F. Sturtevant Co.	......	1	4	Flat belt	Body	Edison	298	....	....
	4	Diners	6-1934	Ice	Ice	Airtrol-Rails Co.	......	1	5	Flat belt	Body	Edison	426	....	....
B. & O.	5	Diners	1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body				
	15	Comb.	1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body				
	2	Cafe-club	1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body				
	1	Lounge	1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body	Exide, USL and K.W.	576, 864 and 1,000	....	....
	6	Reclin. chair	1934	Mech.	Freon	B. & O.—York	Motor	2	1—7½ 1—4	Flat belt-gear Flat belt	Body Body				
	30	Coaches	1934	Mech.	Freon	B. & O.—York	Motor	2	1—4 1—7½	Flat belt Flat belt-gear	Body Body				
C. & O.	4	Salon-coach	4-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Exide	350	a. c.	220
	1	Business	5-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	2	1—4 1—4	Flat belt V-belt-gear	Body Body	Edison	1,024	a. c.	220
	1	Business	2-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	2	1—4 1—4	Flat belt V-belt-gear	Body Body	Edison	1,024	a. c.	220
C. B. & Q.	2	Coach-lounge[2]	4-1934	Mech.	Freon	G. E.—York	Motor	1	25	V-belt from Diesel engine	....	Exide	450 at 64 V.	a. c.	220
	5	Diners	6-1934	Ice	Ice	C. B. & Q.—Frigidaire	......	1	4	Flat belt	Body	Exide	500	....	....
	3	Diners	6-1934	Ice	Ice	C. B. & Q.—Trane	......	1	4	Flat belt	Body	Gould	600	....	....
	1	Diner	5-1934	Mech.	Freon	Frigidaire	Motor	2	15	V-belt	Trucks	Gould	600	....	....
	1	Lounge	5-1934	Mech.	Freon	Frigidaire	Motor	2	1—5 1—15	Gear V-belt	Body Truck	Edison	1,024	a. c.	220
	1	Lounge	5-1934	Mech.	Freon	Frigidaire	Motor	2	1—4 1—15	V-belt V-belt	Truck Truck	Edison	2,048	a. c.	220
	2	Lounge	5-1934	Ice	Ice	C. B. & Q.—Frigidaire	......	1	4	V-belt	Truck	Edison	2,048	a. c.	220
	1	Lounge	6-1934	Ice	Ice	C. B. & Q.—Frigidaire	......	1	4	V-belt	Truck	Edison	1,024	a. c.	220
	2	Lounge-diners	6-1934	Ice	Ice	C. B. & Q.—Trane	......	1	4	V-belt	Truck	Edison	1,024	....	....
	3	Lounge-diners	9-1934	Mech.	Freon	Frigidaire	Motor	1	15	Flat belt	Body	Gould	500	....	....
	2	Cafe-chair	5-1934	Ice	Ice	C. B. & Q.—Trane	......	1	4	V-belt	Truck	Gould	1,000	a. c.	220
	2	Chair	6-1934	Ice	Ice	C. B. & Q.—Trane	......	1	5	Flat belt V-belt	Body Truck	Edison Gould	426 850	....	....
C. & E. I.	2	Coach	6-1934	Ice	Ice	Safety C. H. & L.	......	1	4	Flat belt	Body	Gould	600	d. c.	32
	2	Comb.	5-1934	St. eject.	Water	Safety C. H. & L.	......	1	10	Flat belt	Body	Exide	1,000	d. c.	32
C. M. St. P. & P.	2	Diners	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	1—5 1—10	Flat belt V-belt	Body Truck	Exide	850	d. c.	32
	2	Club	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	5	Flat belt	Body	Exide	850	d. c.	32
	7	Cafe-obs.	6-1934	St. eject.	Water	Safety C. H. & L.	......	1	10	V-belt-gear	Body	Exide	850	d. c.	32
	11	Diners	6-1934	St. eject.	Water	Safety C. H. & L.	......	1	10	V-belt-gear	Body	Exide	850	d. c.	32

Air-Conditioned Passenger Cars Placed in Service Since January 1, 1934 (Continued)

Railroad	No. of cars	Type of car	Date equipped	Type of system	Refrigerant	Manufacturer of system	Compressor drive	Generators: No.	Generators: Capacity, kw.	Generators: Type of drive	Generators: Type of mounting	Storage batteries: Make	Storage batteries: Amp.-hr. capacity[1]	Outside power supply: a. c. or d. c.	Outside power supply: Volts
C. & N. W.	4	Diners	1934	Ice	Ice	Trane	......	1	4	Flat belt	Body	Exide	400	....	....
	1	Lounge	6-1934	Mech.	Methyl-chloride	Melcher	Motor	1	4	Spicer gear	Body	Exide	400	....	....
								1	7½	V-belt-gear	Body	Exide	800	....	....
	2	Cafe-lounge	6-1934	Ice	Ice	Safety C. H. & L.	......	1	4	Flat belt	Body	Exide	400	....	....
	3	Lounge	6-1934	Ice	Ice	Young Rad. Co.	......	1	4	Flat belt	Body	Exide	400	....	....
	1	Lounge	6-1934	Ice	Ice	Trane	......	1	4	Flat belt	Body	Exide	400	....	....
	6	Diners	6-1934	Ice	Ice	Trane	......	1	4	Flat belt	Body	Exide	400	....	....
C. R. I. & P.	4	Bagg.-club	6-1934	Ice	Ice	A. C. & F.	......	1	4	Flat belt	Body	USL	450	d. c.	32
	3	Cafe-lounge	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Exide	850	d. c.	32
												Gould	850	d. c.	32
												USL	850	d. c.	32
	4	Obs.-lounge	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	2 Exide	850	d. c.	32
												1 USL	850	d. c.	32
												1 Gould	850	d. c.	32
	5	Diners	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	2 Gould	850	d. c.	32
												1 Exide	850	d. c.	32
												2 USL	850	d. c.	32
	1	Cafe-lounge	6-1934	Ice	Ice	A. C. & F.	......	1	4	Flat belt	Body	USL	450	d. c.	32
D. L. & W.	2	Diners	6-1934	Ice	Ice	Safety C. H. & L.	......	1	5	Flat belt	Body	Lead	600	....	....
	4	Diners	6-1934	Ice	Ice	Safety C. H. & L.	......	1	4	Flat belt	Body	Lead	600	....	....
	2	Buffet	6-1934	Ice	Ice	Safety C. H. & L.	......	1	5	Flat belt	Body	Lead	600	....	....
	1	MU-club	6-1934	Ice	Ice	Safety C. H. & L.	......	1	5	Motor	Body	None	....	....	....
D. & R. G. W.	5	Diners	6-1934	Ice	Ice	....	......	1	3.2	Flat belt	Body	Edison	520	....	....
	7	Obs.-lounge	6-1934	Ice	Ice	....	......	1	3.2	Flat belt	Truck	Edison	480	....	....
Erie	14	Coaches	7-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	675	....	....
	2	Coach-buffet	7-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	675	....	....
	2	Diners	7-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	750	....	....
	1	Business	7-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	900	a. c.	220-440
	1	Business	8-1934	St. eject.	Water	Safety C. H. & L.	......	1	4	Flat belt	Body	Edison	900	a. c.	220-440
								1	10	Flat belt	Body				
Great Northern	1	Business	7-1934	Ice	Ice	R. R. Co.	......	1	4	Gear	Body	Exide	600	....	....
	10	Diners	4-1934	Ice	Ice	P. C. & M. C.	......	1	5	Gear	Body	Exide	600	....	....
	2	Diners	4-1934	Ice	Ice	P. C. & M. C.	......	1	4	Gear	Body	Exide	350	....	....
Lehigh Valley	2	Diners	1934	Mech.	Freon	Frigidaire	Motor	1	10	Flat belt	Body	Exide	1,000	a. c.	220
								1	5	Flat belt	Body	Exide	1,000	a. c.	220
L. & N.	8	Diners	8-1934	St. eject.	Water	Safety C. H. & L.	......	1	7.5	Flat belt	Body	Exide	800	....	....
Maine Central	2	Comb.	6-1934	Ice	Ice	B. F. Sturtevant Co.	......	1	4	Flat belt	Body	Exide	300	....	....
	5	Coaches	7-1934	Ice	Ice	B. F. Sturtevant Co.	......	1	4	Flat belt	Body	Exide	300	....	....
M-K-T	4	Diners	1934	St. eject.	Water	Safety C. H. & L.	......	1	5	V-belt	Body	2 Exide	1,000	....	....
								1	4	Flat belt	Body	2 USL	1,000	....	....
Missouri Pacific	1	Business	3-1934	Mech.	Freon	Frigidaire	Motor	1	10	Gear	Body	Gould	2,000	....	....
								1	20	Gear	Truck	......	......	a. c.	220
	2	Coach-parlor	8-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	1-600	....	....
													1-750	....	....
	1	Lounge	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	750	....	....
	3	Lounge-diners	6-1934	Mech.	Freon	Westinghouse	Motor	1	15	Gear	Truck	Edison	900	a. c.	220
	2	Lounge-diners	6-1934	Mech.	Freon	Frigidaire	Motor	1	15	Gear	Truck	Edison	900	a. c.	220
	2	Lounge-diners	6-1934	Mech.	Freon	Frigidaire	Motor	1	15	V-belt-gear	Body	Gould	1,000	a. c.	220
	1	Diner	6-1934	Mech.	Freon	Frigidaire	Motor	1	15	Gear	Truck	Edison	900	a. c.	220
	3	Lounge-diners	6-1934	St. eject.	Water	Safety C. H. & L.	......	2	4	Flat belt	Body	Edison	750	....	....
	3	Lounge-diners	6-1934	Ice	Ice	....	......	1	4	Flat belt	Body	Edison	375	....	....
	3	Parlor	6-1934	Ice	Ice	....	......	1	4	Flat belt	Body	Edison	375	....	....
	4	Coach-club	6-1934	Ice	Ice	....	......	1	4	Flat belt	Body	Edison	375	....	....
	1	Business	7-1934	Ice	Ice	....	......	2	4	Flat belt	Body	Edison	900	....	....
N. C. & St. L.	2	Diners	7-1934	St. eject.	Water	Safety C. H. & L.	......	1	7½	Flat belt	Body	Edison	852	....	....
	3	Cafe-parlor	1934	St. eject.	Water	Safety C. H. & L.	......	1	7½	Flat belt	Body	Edison	852	....	....
N. Y. Central	9	Coaches	7-1934	Mech.	Freon	Frigidaire	Motor	1	20	Gear	Truck	USL and Gould	450 at 64 V	....	......
	6	Diners	7-1934	Mech.	Freon	Frigidaire	Motor	1	20	Gear	Truck	USL	600 at 64 V	....	....
	22	Coaches	5-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	USL and Gould	450	a. c.	220
	32	Diners	5-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	5	Flat belt	Body	Exide	600 at 64 V	a. c.	220

Air-Conditioned Passenger Cars Placed in Service Since January 1, 1934 (Continued)

Railroad	No. of cars	Type of car	Date equipped	Type of system	Refrigerant	Manufacturer of system	Compressor drive	Generators				Storage batteries		Outside power supply	
								No.	Capacity, kw.	Type of drive	Type of mounting	Make	Amp.-hr. capacity[1]	a. c. or d. c.	Volts
N. Y. C. (B. & A.)	4	Diners	5-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	5	Flat belt	Body	Edison	450 at 64 V	a. c.	220
N.Y.C.& St.L. (Nickel Plate)	1	Business	3-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	2	4	Flat and V-belt	Body	Edison	1,024	a. c.	220
N. Y., N. H. & H.	14	Diners	6-1934	Ice	Ice	B. F. Sturtevant Co.	......	..	....	......	......	......	......	....	....
	9	Comb.	6-1934	Mech.	Freon	Safety C. H. & L.	Motor	2	1-4	Flat belt	Body	Exide	1,000	....	....
									1-15	V-belt-gear	Body				
	6	Smoker	6-1934	Mech.	Freon	Safety C. H. & L.	Motor	2	1-4	Flat belt	Body	Exide	1,000	....	....
									1-15	V-belt-gear	Body				
	27	Coaches	6-1934	Mech.	Freon	Safety C. H. & L.	Motor	2	1-4	Flat belt	Body	Exide	1,000	....	....
									1-15	V-belt-gear	Body				
N. & W.	7	Diners	6-1934	Mech.	Freon	Frigidaire	Motor	1	15	V-belt	Truck	Edison	300 at 110 V	a. c.	220
Northern Pacific	10	Obs.	6-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	5 Exide	570	a. c.	220
												5 Gould	570		
	9	Diners	6-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	5	Flat belt	Body	Exide	570	a. c.	220
Pennsylvania	25	Diners	1934	Mech.	Freon	Frigidaire	Motor	1	15	Gear	Truck	......	800	....	....
	5	Diners	1934	Mech.	Freon	Frigidaire	Motor	1	15	V-belt-gear	Body	......	800	....	....
	37	Coaches	1934	Ice	Ice	R. R. Co.	......	1	4.8	Flat belt	Body	......	500	....	....
	27	Comb.	1934	Ice	Ice	R. R. Co.	......	1	4.8	Flat belt	Body	......	500	....	....
	18	Coaches	1934	Ice	Ice	R. R. Co.	......	1	4.8	Flat belt	Body	......	500	....	....
	1	M. u. coach	1934	Mech.	Freon	Baldwin-Southwark	Motor	..	....	......	......	None	......	....	....
	1	Coach	1934	Mech.	Freon	Frigidaire	V-belt from axle	1	4.8	Flat belt	Body	......	800	....	....
	1	Coach	1934	Mech.	Freon	York	Motor	1	10	V-belt	Body	......	800	....	....
	1	Coach	1934	Mech.	Freon	General Electric	Motor	1	15	Gear	Truck	......	800	....	....
Pullman Co.	12	Parlor-obs.	1934	St. eject.	Water	Safety C. H. & L.	......	1	4	V-belt	Body	Exide	550	....	....
	13	Parlor-obs.	1934	Mech.	Freon	P. C. & M. C.	Motor	2	1-4	V-belt	Body	Exide	1,000	....	....
									1-15	V-belt-gear	Body				
	68	Parlor-obs.	1934	Ice	Ice	Pullman		1	4	V-belt	Body	Exide	600	....	....
	7	Parlor	1934	Mech.	Freon	P. C. & M. C.	Speed Reducer	1	4	V-belt	Body	Exide	550	....	....
	47	Parlor	1934	Mech.	Freon	P. C. & M. C.	Motor	2	1-4	V-belt	Body	Exide	1,000	....	....
									1-15	V-belt-gear	Body				
	110	Parlor	1934	Ice	Ice	Pullman	......	1	4	V-belt	Body	Exide	600	....	....
	34	Composite	1934	St. eject.	Water	Safety C. H. & L.	......	2	4	V-belt	Body	Exide	850	....	....
	81	Composite	1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	V-belt	Body	Exide	550	....	....
	33	Composite	1934	Mech.	Freon	P. C. & M. C.	Motor	2	1-4	V-belt	Body	Exide	1,000	....	....
									1-15	V-belt-gear	Body				
	74	Composite	1934	Ice	Ice	Pullman	......	1	4	V-belt	Body	Exide	600	....	....
	260	Sleepers	1934	Ice	Ice	Pullman	......	1	4	V-belt	Body	Exide	600	....	....
	23	Sleepers	1934	St. eject.	Water	Safety C. H. & L.	......	2	4	V-belt	Body	Exide	850	....	....
	288	Sleepers	1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	V-belt	Body	Exide	550	....	....
	111	Sleepers	1934	Mech.	Freon	P. C. & M. C.	Motor	1	4	V-belt	Body	Exide	1,000	....	....
Reading Co.	1	Club-coach	7-1934	Mech.	Freon	York	Motor	2	1-4	Flat belt	Body	Exide	1,000	a. c.	220-440
									1-7½	Flat belt	Body				
	2	Cafe	7-1934	Mech.	Freon	York	Motor	2	1-4	Flat belt	Body	1 Exide	1,000	a. c.	220-440
									1-7½	Flat belt	Body	1 USL	1,000	a. c.	220-440
		Comb.	7-1934	Mech.	Freon	York	Motor	2	1-4	Flat belt	Body	Exide	1,000	a. c.	220-440
									1-7½	Flat belt	Body				
	4	Coaches	7-1934	Mech.	Freon	York	Motor	2	1-4	Flat belt	Body	3 Exide	1,000	a. c.	220-440
									1-7½	Flat belt	Body	1 USL			
R. F. & P.	2	Coaches	8-1934	Mech.	Freon	West.-Frigidaire	Motor	1	15	Gear	Truck	Edison	300[3]	a. c.	220
	1	Parlor-cafe	9-1934	Mech.	Freon	West.-Frigidaire	Motor	1	15	Gear	Truck	Edison	450[3]	a. c.	220
	2	Diners	10-1934	St. eject.	Water	Safety C. H. & L.	......	1	10	V-belt-gear	Body	Edison	1-600	....	....
													1-750		
	2	Diners	11-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	1-600	....	....
													1-375		
Seaboard A. L.	1	Parlor-diner	4-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	300	a. c.	220
	2	Obs.-diners	5-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	375	a. c.	220
	3	Coach-diners	4-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	375	a. c.	220
	5	Comb.	5-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	3	Flat belt	Body	Edison	300	a. c.	220
	5	Coaches	4-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	3	Flat belt	Body	Edison	300	a. c.	220
	2	Diners	4-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	375	a. c.	220
	8	Diners	1-1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	375	a. c.	220

Air-Conditioned Passenger Cars Placed in Service Since January 1, 1934 (Continued)

Railroad	No. of cars	Type of car	Date equipped	Type of system	Refrigerant	Manufacturer of system	Compressor drive	Generators: No.	Generators: Capacity, kw.	Generators: Type of drive	Generators: Type of mounting	Storage batteries: Make	Storage batteries: Amp.-hr. capacity[1]	Outside power supply: a. c. or d. c.	Outside power supply: Volts
St. L.-S. F.	5	Coaches	1934	Ice	Ice	R. R. Co.	......	1	3	Flat belt	Body	Exide	450	....	....
	2	Chair	1934	Ice	Ice	R. R. Co.	......	1	3	Flat belt	Body	Exide	450	....	....
	2	Lounge	1934	Ice	Ice	R. R. Co.	......	2	4	Flat belt	Body	Exide	900	....	....
	2	Club-coach	1934	Ice	Ice	R. R. Co.	......	2	1–3	Flat belt	Body	Exide	900	....	....
									1–4	Flat belt	Body				
	1	Lounge-diner	1934	Ice	Ice	R. R. Co.	......	2	1–3	Flat belt	Body	Exide	900	....	....
									1–4	Flat belt	Body				
Sou. Pac.	4	Obs.	6–1934	Ice	Ice	R. R. Co.	......	1	5	3 Flat belt	Body	Edison	750	....	....
								1	4	1 V-belt	Truck	Edison	450	....	....
	2	Chair	6–1934	Ice	Ice	R. R. Co.	......	1	4	Flat belt	Body	Edison	450	....	....
	4	Club	6–1934	Ice	Ice	R. R. Co.	......	1	4	Flat belt	Body	Edison	450	....	....
	3	Lounge	6–1934	Ice	Ice	R. R. Co.	......	1	5	Flat belt	Body	Edison	750	....	....
	5	Diners	6–1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	450	a. c.	220-240
Union Pac.	16	Diners	6–1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Edison	375	a. c.	220
	22	Obs.	6–1934	Mech.	Freon	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	19 Exide	500	a. c.	220
												3 Edison	375		
Wabash	2	Cafe-parlor	7–1934	Ice	Ice	R. R. Co.	......	1	4	Flat belt	Body	Exide	350	....	....
	7	Chair	6–1934	Ice	Ice	R. R. Co.	......	1	3	Flat belt	Body	Exide	350	....	....
	5	Cafe-Lounge	7–1934	Ice	Ice	R. R. Co.	......	1	4	Flat belt	Body	Exide	350	....	....
Western Pac.	4	Diners	6–1934	St. eject.	Water	Safety C. H. & L.	......	2	9	Flat belt	Body	Edison	750	....	....

[1]All batteries shown are 32 volts, except where otherwise noted.
[2]Two units of streamlined train "Zephyr."
[3]Compressor does not operate from batteries.

Summary of types of Systems and Refrigerants Used

Type of System

Railroad	No. cars	Electro-mech.	Direct-mech.	Ice	Steam ejector	Refrigerant used: Freon	Water	Ammonia	Methyl-chl.
Alton	8	8	...	...	...	8	...	...	...
Atlantic Coast Line	7	...	...	...	36	...	36	...	...
Atchison, Topeka & Sante Fe	36	...	...	...	7	...	7	...	...
Boston & Maine	10	...	...	10	...	...	10	...	...
Baltimore & Ohio	59	59	...	...	...	59	...	...	...
Chesapeake & Ohio	6	...	6	...	...	6	...	...	...
Chicago, Burlington & Quincy	25	8	...	17	...	8	17	...	...
Chicago & Eastern Illinois	4	...	...	2	2	...	4	...	...
Chicago, Milwaukee, St. Paul & Pacific	22	...	...	...	22	...	22	...	...
Chicago & North Western	17	1	...	16	...	...	16	...	1
Chicago, Rock Island & Pacific	17	...	...	5	12	...	17	...	...
Delaware, Lackawanna & Western	9	...	...	9	...	...	9	...	...
Denver & Rio Grande Western	12	...	...	12	...	...	12	...	...
Erie Railroad	20	...	...	...	20	...	20	...	...
Great Northern	13	...	...	13	...	...	13	...	...
Lehigh Valley	2	2	...	...	...	2	...	...	...
Louisville & Nashville	8	...	...	...	8	...	8	...	...
Maine Central	7	...	...	7	...	...	7	...	...
Missouri-Kansas-Texas	4	...	...	...	4	...	4	...	...
Missouri Pacific	26	9	...	11	6	9	17	...	...
Nashville, Chattanooga & St. Louis	5	...	...	...	5	...	5	...	...
New York Central	69	15	54	...	...	69	...	...	...
New York Central (B. & A.)	4	...	4	...	...	4	...	...	...
Nickel Plate	1	...	1	...	...	1	...	...	...
New York New Haven & Hartford	56	42	...	14	...	42	14	...	...
Norfolk & Western	7	7	...	...	...	7	...	...	...
Northern Pacific	19	...	19	...	...	19	...	...	...
Pennsylvania Railroad	116	34	...	82	...	34	82	...	...
Pullman	1161	204	376	512	69	580	581	...	...
Reading Company	9	9	...	...	...	9	...	...	...
Richmond, Fredericksburg & Potomac	7	3	2	...	2	5	2	...	...
Seaboard Air Line	26	...	26	...	...	26	...	...	...
St. Louis-San Francisco	12	...	...	12	...	...	12	...	...
Southern Pacific	18	...	5	13	...	5	13	...	...
Union Pacific	38	...	38	...	...	38	...	...	...
Wabash	14	...	...	14	...	...	14	...	...
Western Pacific	4	...	...	...	4	...	4	...	...
TOTAL	1878	401	531	749	197	931	946	0	1

Motive Power Requirements For High-Speed Trains[1]

Part I

By G. I. Wright[2] and P. A. McGee[3]

Relative operating costs of main-line and suburban passenger trains with steam, electric and oil-electric motive power

DESPITE recent publicity and developments in the design of light-weight equipment and internal-combustion motive power for high-speed passenger trains, there has been little, if any, published analysis of the motive-power requirements and economics involved in the operation of trains of various sizes, shapes and weights at high speeds, say for 75 to 125 m.p.h.

The first step necessary in such analysis is to establish rational definitions for the most important dimensions of a train. The quantity of passenger transportation produced is usually expressed in "passenger-train miles" or "car miles." When it is recognized that trains may vary in length from 50 ft. to 1,500 ft. and cars from 50 ft. to 80 ft. with corresponding variations in weight, it is seen that these indices give no real measure of transportation. "Passenger-seat miles" is equally unsatisfactory as the linear space occupied per seat varies from 9 in. to 2 ft. or over.

The motive power supplies energy to accelerate a train, to overcome air and frictional resistance and to ascend grades. Air resistance at any speed is a function of the cross-section area and shape of a train together with its length, while frictional resistance is proportional to weight. Accelerating and gravity forces on grades are also proportional to weight. Remembering that the motive power itself usually occupies some of the total train length, we then have four important physical dimensions of a passenger train as follows:

1—Total length, including that of the motive power unit.
2—Net length available for passengers, mail or baggage.
3—Average weight per foot of gross length.
4—Average weight per foot of net length.

Assumptions and Tractive Resistance Values

With these ruling dimensions we are in a position to study the effects of train shape and weight on the tractive resistance of any length train running at any practicable speed.

We will consider both conventional and light-weight rolling stock. With each we will assume two types of construction, namely conventionl design and revised design with specially shaped ends which cause a considerable reduction in head-end and tail-end air resistance.

With these two types of trains and the two end formations, tractive resistance values for any length train may be calculated according to recognized formulae. The principal data of types of rolling stock and weight characteristics of different types of motive power to be considered in this study are as follows:

1—*Conventional Passenger Coach.*—Height from rail, 13 ft. 6 in. to 14 ft.; width, 10 ft.; front area, 120 sq. ft.; circumference, 41 ft.; weight per foot, 2,000 lb. for main line and 1,200 to 1,400 lb. for suburban; load, per foot, 400 lb.
2—*Light-Weight Passenger Coach.*—Height from rail, 11 ft.; width, 8 ft. 9 in.; front area, 100 sq. ft.; circumference, 32 ft.; weight per foot, 700 to 800 lb. for main line or suburban; load per foot, 400 lb.
3—*Steam Locomotive.*—Weight per horsepower at driving wheels of locomotive with tender, including fuel and water, 200 lb. for main line and 150 lb. for suburban; horsepower per foot of locomotive and tender, 20 to 30.
4—*Electric Locomotive.*—Weight per horsepower (continuous rating) at driving wheels, 100 lb.; horsepower per foot, 50 to 60.
5—*Electric MU Equipment.*—Weight per horsepower at driving wheels, 50 lb.
6—*Oil-Electric Equipment.*—Including fuel, water and accessories, 100 lb. per horsepower at driving wheels, or 25 to 35 hp. per foot.

Total train resistance is made up of three combinations: First, journal friction, rolling and track resistances; second, flange friction, car oscillation and swaying, and third, air drag and wind effects. Their values are greatly influenced by atmospheric conditions, temperature, condition of track and type of vehicle. For any given set of conditions the first combination is considered constant and independent of speed. This resistance, however, is a function of axle bearing pressure and decreases with increase in axle load. The second combination varies directly with the speed. It is influenced by the truck wheel base, steadying effect of a trailer load and effect of track on body oscillations and swaying. The third combination includes all air effects. For general purposes it is assumed that the resistance is caused by the train moving at a given speed through still air. Physical properties of the train which affect this resistance are area and shape of front and rear ends, length of train, nature of surfaces and frequency and nature of car connections. This combination is proportional to the square of the speed and is of great importance at high speeds.

The total train resistance may be represented by an equation including the above three factors as follows:

$$R = A + BV + CV^2 \quad \text{(1)}$$

Where R = total resistance
A = constant depending on axle weight
B = constant depending on conditions outlined
C = constant depending on conditions outlined
V = Speed

Representative values for constants A and B for given train weights per foot are shown on Curve 3 for good track conditions and at a temperature of 60 deg. F. These constants have been taken from values proposed by Davis.[4]

Values for constant C requires more consideration. Air effects on trains are made up of four parts; head end and rear effects and skin and eddy effects on the longitudinal surfaces. From a purely aerodynamic standpoint, no such simple segregation can be made. For a stream-lined body it is necessary to consider the structure as a whole with reference to the air flowing around it. Under the conditions of a perfectly stream-lined

[1] Abstract of a paper presented before the New York Railroad Club, October 19, 1934.
[2] Chief electrical engineer, Reading Company.
[3] Assistant engineer, Reading Company.

[4] W. J. Davis, Jr., Tractive Resistance of Electric Locomotives and Cars. General Electric Review, October, 1926.

train which would be shaped like a dirigible, automobile or street car where an approximation to perfect stream-lining may be obtained without introducing an abnormal height. However, with a long train there is little possibility of even approaching a perfect stream-line formation and tests by Goldsborough in 1906 and Schmidt and Dunn of the University of Illinois, confirm the feasibility of considering the air resistance effect in the constituent parts named. For convenience in estimating, the usual resistance formulas developed for conventional trains give a constant which, when multiplied by the front area for the front coach or locomotive and trailing coaches gives the total resistance of the train. This assumption is correct only when there is a definite relation between front area and length of individual coaches.

The air resistance coefficients developed by Goldsborough for various types of car ends were as follows for single cars:

Flat ends	.00340
Standard ends	.00225
Parabolic ends	.00120
Parabolic wedge ends	.00113

Other authorities give values for ends, not perfectly described, varying between .0027 and .0024. These coefficients when multiplied by the front-end area give the total front and rear resistance together with the skin and eddy resistances of the car. Tests by Schmidt and Dunn for trailer cars give skin and eddy effect coefficients varying between .0000162 for 58-ft. cars to .0000146 for 70-ft. cars, all having an end cross section of 120 sq. ft.

Skin and eddy resistance of the head vehicle is probably different from that of succeeding cars, but for speeds obtained today the resistance of trailer cars may be looked upon as equal when similarly dimensioned with the exception of the rear car. With this understanding it is permissible with present rolling stock and trains of at least two cars, to consider the front and rear resistance coefficient separately from the skin and eddy coefficient.

Accepting the average developed coefficients, the following values are obtained:

Total air resistance conventional cars	$= .0024aV^2$	(2)
Total air resistance special-shaped cars	$= .0012aV^2$	(3)
Skin and eddy resistance standard vestibule cars	$= .00001464bV^2$	(4)

Where a = Area of front and rear ends of car.
b = Area of car longitudinal surfaces.
V = Speed in miles per hour.

Taking the average circumference of a standard car as 41 ft. and of a light-weight car as 32 ft. the skin and eddy effects may be deducted from equation 2 and 3 with the following results for total front and rear air resistance.

Conventional train and ends	$= .246V^2$	(5)
Conventional train with special ends	$= .101V^2$	(6)
Light-weight train with conventional ends	$= .207V^2$	(7)
Light-weight train with special ends	$= .087V^2$	(8)

With equations 5 to 8 inclusive we can estimate front and rear air resistances and with equation 4 skin and eddy resistance per foot of any train section or average circumference above some minimum length with surface conditions such as exist with standard vestibule cars of 70 ft. length. With these equations for air resistance and Curve 3 for friction and flange resistance, curves for the total resistance of trains on a length basis may be constructed, as shown in Curve 1.

Curve No. 1

The top portion of Curve 1 gives constant resistance *A* commonly called "journal resistance." This resistance is given on a weight per foot and length basis; the weight per foot being the average weight for the total train and the length the total train length including motive power.

The centre set of curves gives variable friction factor *B* commonly called "flange resistance," which varies as a function of the speed. This resistance also is given on a weight per foot and length basis.

The bottom portion gives air resistance factor *C* for various train lengths of four different types.

Due to the possibility of irregularities occurring in air coefficients with trains shorter than 100 ft. this is the minimum length shown. It should also be noted that Curve 1 does not attempt to give air resistance factors for radical stream-lining.

The air resistance with conventional coaches and specially shaped train ends and small-size coaches with special train ends are shown in Table I as a percentage of the conventional standard-end train.

Table I—Percentage of Air Resistance per Foot with Different Type Coaches

Total train length	Conventional coaches: Standard ends	Conventional coaches: Special ends	Small-size coaches special ends
100 ft.	100	53.4	46.6
500 ft.	100	73.4	57.8
1,000 ft.	100	83.4	64.6

The reduction in air resistance per foot by increasing the length of train for both standard and special-ends is shown in Table II.

Table II—Percentage of Air Resistance per Foot with Different Length Trains

Total train length	Train with standard ends	Train with special ends
100 ft.	100	100
500 ft.	36.7	44.6
1,000 ft.	28.0	40.5

Reduction in air resistance obtained with reduced-size coaches and special shaped ends may possibly be increased by refinement in train surfaces, attention to shape and connections between coaches. Such further reduction, however, cannot be considerable, as resistance caused by eddies along the longitudinal surfaces of the train which is the principal force affected by formation and shape of train sides, is relatively a small part of total train resistance.

With due allowance for increase in friction with decrease in axle load, the reduction in journal and variable friction resistance is considerable with reduction in weight. As an example, consider a conventionl steam train with an average weight of 3,000 lb. per gross foot and a total length of 600 ft. in comparison with a light-weight electric motor-car train weighing 1,250 lb. per foot and having an overall length of 500 ft. At 100 m.p.h. total friction resistances of the two trains are:

Conventional steam train	5,280 lb.
Light-weight electric train	2,300 lb.

The difference of 2,980 lb. at 100 m.p.h. represents practically 800 hp. and this saving is directly obtained with light-weight motive power equipment and light-weight coaches.

Consider now the air resistances of these two trains of 600 ft. and 500 ft. respectively at 100 m.p.h.:

Conventional steam train	6,000 lb.
Light-weight electric train	3,150 lb.

The difference of 2,850 lb. at 100 m.p.h. represents 760 hp. which is actually less than the saving obtained with reduced friction resistance.

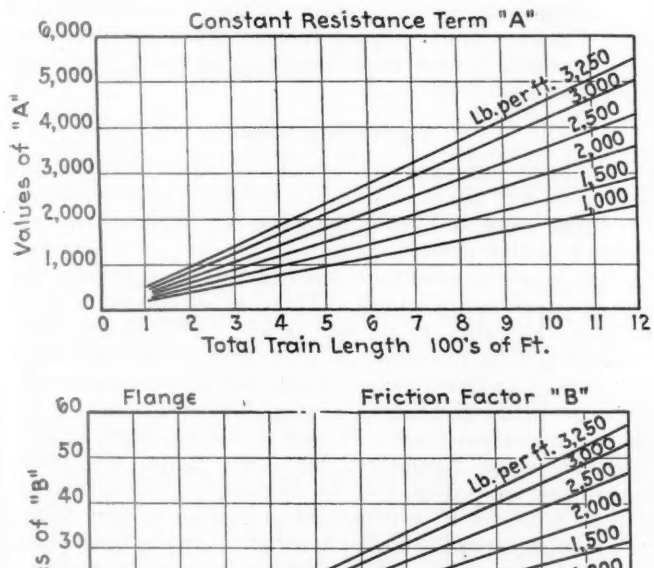
From these considerations it may be concluded that the most practical way to reduce train resistance at high speeds is to run trains at maximum length, i. e., consolidate as many trains as possible into one, reduce the cross section and the weight to a minimum. Where, however, high speeds are required with trains of short

length the shaping of the ends is important. Effects of tractive resistance on varying train length can be best illustrated by considering horsepower requirements per foot of net train lengths at various speeds.

Train Characteristics

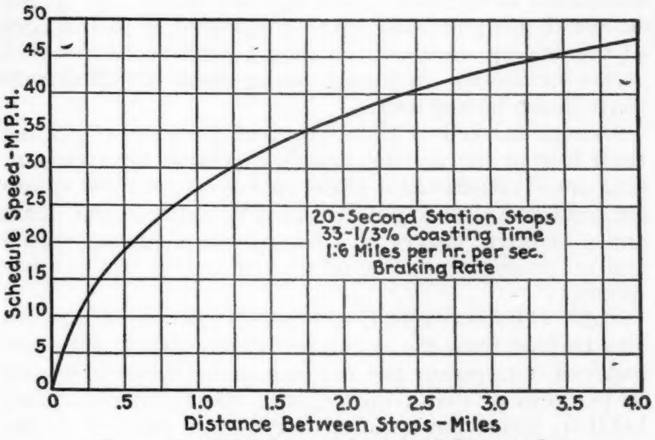
The most important operating indices of main-line trains with comparatively long distances between stops and few slow downs are free running speed on level tangent track, free running speed on the ruling grade and the rate of acceleration at high speed. These three indices explain the operating possibilities of any main-line train with a given permissible maximum speed and rate of braking.

With all types of motive power the initial rate of acceleration is limited only by adhesive weight. As the speed increases, however, the rate of acceleration is limited by the available power, which in the case of the steam locomotive is boiler capacity; in the oil-electric, the shaft horsepower, and in the electric, the available power of the distribution lines. With electric power supplied from a large available source of energy, it is normally possible to carry the initial rate of acceleration to quite high speeds, the only limitation being adhesive weight. In order fully to exploit this available energy with electric power it is necessary to use as much of the total train weight as possible for tractive adhesion and in consequence it becomes desirable to distribute the traction motors throughout the train, or, in other words, employ distributed motive power.

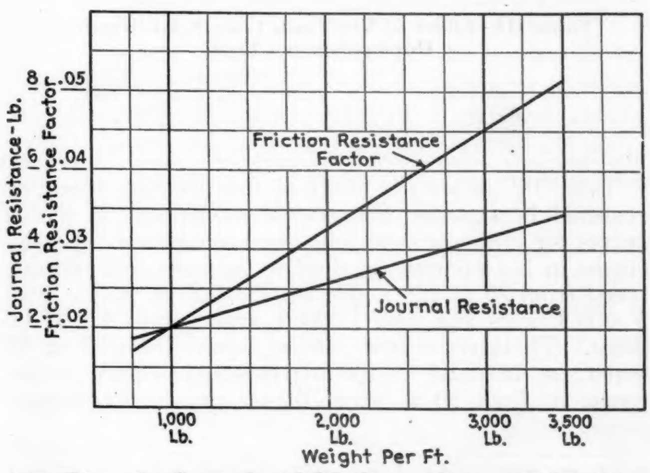


R = A + BX + CV²
R = Total resistance, lb.
V = Speed, m.p.h.

Curve 1—Train resistance values



Curve 2—Suburban train schedule speeds



Curve 3—Journal and friction resistance values

With these considerations in mind the most instructive analysis and comparison can be made with (1) head-end steam power as employed with conventional steam trains; (2) head-end electric power as employed on main-line trains; (3) distributed electric power as employed with suburban motor-car trains, and (4) distributed or concentrated oil-electric power built into the train or coach structure.

Further considerations will be confined to two types of coaches, namely, trains with conventional coaches and standard-shaped ends and trains with small-size coaches and special-shaped ends. These are the two extreme cases shown on Curve 1 and whose characteristics have already been given.

We will now develop characteristic curves of horsepower required per net foot of train length for the three types of motive power and two types of coaches to obtain free running speeds on level track of 70, 85, 100, and 125 m.p.h. and further show the free running speeds on a ruling grade of 0.5 per cent and the rate of train acceleration in miles per hour per second on level track at the speed where electric power would normally

commence to decrease its horsepower output. It should be noted that the horsepower considered is at the rims of the driving wheels which should not be confused with steam-locomotive indicated horsepower or oil-electric shaft brake horsepower.

Curves marked *A* show required horsepower per net train foot at the driving wheels to obtain the free running speed considered. These curves do not show values for head-end electric power which lie between the steam and oil-electric curves at 70 m.p.h. free running speed and on or slightly below oil-electric curves at the other speeds.

Table III shows effects of length on horsepower which may be read from the *A* curves. With a 500-ft. train the required horsepower per net foot varies between 44 and 60 per cent of that required with 100-ft. trains. With 1,000-ft. trains the required horsepower per foot is between 36 and 58 per cent of the 100 ft. train.

Table III—Effect of Net Train Length on Required Horsepower per Foot

Net train length	Horsepower as a percentage of 100-ft. train
100 ft.	100
500 ft.	44 to 60
1,000 ft.	36 to 58

Table IV shows the effect of free running speed on required horsepower between limits shown on the *A* curves for different types of power considered. The increase in horsepower required to increase free running speed from 70 to 125 m.p.h. is, with 100-ft, trains, from 5 to 6.3 times and with 1,000-ft. trains from 4.2 to 4.6 times. To increase free running speed from 70 to 85 m.p.h., or from 85 to 100 m.p.h would require an increase of from 50 to over 70 per cent in the motive-power rating.

Table IV—Effect of Speed on Required Horsepower per Net Foot Horsepower Is Referred to that Required at 70 m.p.h.

Speed	100-ft. train	500-ft. train	1,000-ft. train
70 m.p.h.	100	100	100
85 m.p.h.	150 to 170	150 to 157	150 to 155
100 m.p.h.	256 to 295	250	230
125 m.p.h.	500 to 634	430 to 500	420 to 460

In order to interpret properly the characteristics shown on the *A* curves, it is necessary to consider the free running speed of the various trains on some ruling grade which we are taking at 0.5 per cent and also to note the rate of acceleration at high speeds.

Free Running Speed and Acceleration at High Speed

These values are shown for various trains and train lengths in the *B* series of curves. Since there is little difference between conventional and light-weight trains, only one curve is shown for each type of power. Free running speeds and rates of acceleration shown on the *B* curves were obtained by assuming the same horsepower as on *A* curves with the exception of electric power accelerating rates where a horsepower output 65 per cent greater than that shown on the *A* curves is assumed. This is the normal overload taken by electric motors during accelerating periods. Values for head-end electric power are not shown as they are practically the same as for distributed electric power.

Referring to series *B* curves, there is a gradual decrease in free running speeds on the 0.5 per cent grade with increase in train length. The drop in free running speed is a maximum with trains of lowest free running speed on the level.

Rates of acceleration shown by the lower series of *B* curves, at the speeds selected, decrease with increase in train length and increase with increase in train free running speed. Speeds at which rates of acceleration are given are as follows: *B1* curves, 30 m.p.h.; *B2* curves, 38 m.p.h.; *B3* curves, 45 m.p.h.; *B4* curves, 55 m.p.h.

The relatively low rates of acceleration with steam and oil-electric power which are never above half those obtained with electric power, is a characteristic difference between self-contained motive power and motive power connected to a large source of power.

In many main line services the accelerating rate at high speeds and free running speeds on grades are more important than the ultimate free running speed on level track. Under such conditions air resistance values and streamlining are of relatively small importance. This explains why tractive resistance formulas which give widely different values result apparently in similar overall train performances.

In a general study of relative train performance it is difficult to include these variable factors as they are the result of local conditions which vary in each case. In consequence we will confine further considerations to the *A* curves and compare relative train performances on the single power requirement to obtain a free running speed on level track.

Operating Costs

The most satisfactory evaluation of the characteristics shown on the *A* curves may be obtained by considering operating costs of such items as are affected by the type of motive power.

The *A* curves give power requirements in horsepower per ft. of net train length. There is, of course, a great lack of flexibility in motive power, particularly when concentrated at the head end, as there is just one train size where motive power is operated at maximum efficiency. With distributed power, which is shown for electric operation on the *A* and *B* curves, there is considerably more flexibility, but here again, the exact assignment of power will be dictated by the minimum size train which it is proposed to operate at any given free running speed. Under normal operating conditions it would not be possible to secure the exact required motive power and generally it may be expected that an excess will be obtained, just as obtains today with the average steam train. In this estimate, however, it will be assumed that the theoretically exact power requirements as shown in the *A* curves, are obtained and all cost data is made on this basis.

The most important items of operating cost which are effected by size, speed, shape and motive power of trains are: Fuel and power, crew, train supplies, terminal charges, engine house, maintenance and fixed charges.

[For curves *A* and *B* see Part II—Editor]

* * *

A New Lullaby.—A delicate tribute to railroad sleeping cars is paid by Professor Salomon, a German inventor, who has just produced a new sleep-inducing machine, according to the Delaware & Hudson Railroad Bulletin. The machine consists of a plain wooden box, mounted on three little legs, and contains a clockwork mechanism that runs for 40 min., emitting a hollow droning sound punctuated by a dull clicking. Prospective purchasers of this antidote for insomnia are told to imagine themselves in a sleeping car, being lulled to sleep by the "clicks from the rails."

This reminds us of a story by Irvin S. Cobb. After returning from a long lecture tour, involving nightly "sleeper jumps," the noted humorist found that he could not sleep in his own home. He finally solved the problem, though. Upon retiring each night, he put a cinder in his eye and had someone shake his bed violently every few minutes. Then he slept perfectly.

EDITORIALS

The 1934 Index

The preparation of the index for the 1934 volume of the *Railway Mechanical Engineer* will have begun when you receive this issue. Copies of the index are mailed only to those subscribers who desire it. Send us your name and address promptly if you did not write for the 1933 index.

Trends in Motive Power

While purchases of locomotives and rolling stock have been insignificant since 1930, the inventory has not been standing still. Retirements of locomotives have been continued throughout the depression at rates not greatly below those prevailing before the depression. As a result there has been a sharp increase in the rate of decline in the number of units. The decline actually began in the middle 1920's, but until the sharp recession in equipment installations in 1931 it was causing little real change in the aggregate available capacity.

Installations of locomotives averaged 1,405 units per year from 1925 to 1930, inclusive, and retirements were at the average rate of 2,890 units per year. There was a decline from 63,974 locomotives owned by the Class I railways at the end of 1925 to 56,582 at the end of 1930. The aggregate tractive force, however, had declined only 60 million pounds from 2,587 million pounds. At the end of 1933, after three years of installations at the average rate of 407 a year and retirements at 2,599 a year, the number of locomotives had declined to 50,802. This decline is about three-fourths as great as that during the preceding six years, but the decline in aggregate tractive force was about 147 million pounds—nearly six per cent in three years.

This represents a definite cleaning up of the inventory. The locomotives retired have been of types which have largely ceased to have any place except in light service. The retirements have little relation to the policies which the railways are developing with respect to the purchase of new equipment when a restoration of traffic and earnings permits them to take up seriously the question of major capital expenditures. They are evidence of a clear recognition of obsolescence at the bottom of the inventory, during a period when curtailed traffic has removed the immediate need for more aggregate equipment capacity and when vanished earnings and credit have made major capital expenditures impossible.

In the reports to Co-ordinator Eastman's Car Pooling Section, as of October 1, 1933, there were 1,046 road locomotives having four-wheel trailer trucks, a characteristic which may be employed roughly to distinguish strictly modern locomotives from those not strictly modern in construction. In the middle group the numerically important freight types are the 2-8-2 and the 2-10-2, of which there are 9,830 and 2,054, respectively. The 4-6-2 and 4-8-2 types, of which there were 5,528 and 1,809, respectively, are the important groups of passenger power and are also used to a limited extent in freight service. It is locomotives from these groups which are being replaced in main-line service by locomotives with the four-wheel trailers, which develop higher sustained horsepower and maintain higher sustained speeds than can be obtained from those now generally employed. There is little place, except on light branch lines, for the locomotives of 4-4-0, 2-6-0, 4-6-0, 2-8-0 and 4-8-0 types, but there were over 18,000 of these locomotives still carried in the property account at the time of the report—groups which have long ceased to be purchased and the average ages of which were from 26 to 34 years. To these may be added the 4-4-2 and 2-6-2 types, making a total of nearly 20,000 units. These are the locomotives which were the least used during the period studied by the Co-ordinator.

These figures, which are also set forth in the table, present a composite picture of a situation which varies widely in its details on different individual railways. On some railroads the light character of the traffic may cause less obsolescence of the old, light types of motive power than must generally be charged against them. In any case, however, the advanced age of many of the units in types which average from 25 to 30 years of age is likely to make them expensive to maintain in relation to the amount of service they can render and, in comparison with modern standards, they are likely to be very inefficient operating units.

The Locomotive Inventory as of October 1, 1933

	No. locos.	Average age of groups, years: From	To
Strictly modern locomotives:			
2-8-4; 2-10-4; 4-6-4; 4-8-4	1,046	3.6	5.7
Principal active main-line types:			
2-8-2; 2-10-2; 4-6-2; 4-8-2	19,221	8.9	18.8
Articulated	1,619	3.0	23.0
Types generally obsolete:			
2-6-0; 2-8-0; 4-4-0; 4-6-0; 4-8-0; 2-6-2; 4-4-2	19,685	25.9	29.9
Types not classified (12 wheel arrangements)	1,051	...	...
Total road locomotives	42,622		

When serious consideration can again be given to

major capital expenditures by the railways the first interest will undoubtedly be in securing efficient and economical motive power for the main-line services. The use of rail motor cars, probably of light weight and streamlined exteriors, as a substitute for light passenger-train service will still further reduce the usefulness of the old steam locomotives of the lighter type. As the use of light-weight passenger cars increases the possibility for lighter motive power will undoubtedly lead to competition between locomotives of the Diesel-electric type and steam locomotives of medium horsepower designed specifically for high speeds. The Diesel locomotive of sufficient horsepower capacity to match modern steam locomotives for heavy road service is still an unknown quantity. It already has its advocates, however, and will soon be placed on trial to determine how far its operating economy will go to justify its high first cost in comparison with the steam locomotive.

Of the 8,803 steam switching locomotives in the Co-ordinator's inventory, 5,796 are of the 0-6-0 type and 2,821 of the 0-8-0 type. The 0-6-0 type averaged 23.1 years of age, while the larger type average 15.2 years. The former are the locomotives which in most cases are being replaced by Diesel-electric switching locomotives which, during the past few years, have been going into service steadily, even if not in large numbers.

Starting Locomotive Fires in Enginehouses

A study of the locomotive smoke problem indicates that one of the most difficult elements is the elimination of smoke from enginehouses, caused by the building of fires in the locomotives. This was confirmed in the survey which was made at Scranton, Pa., last summer and which was commented upon in the November *Railway Mechanical Engineer,* page 403. Contrary to the firmly fixed belief held by many, it is possible to build such fires with very little smoke; this has been shown conclusively in places where attention has been concentrated upon the problem. The difficulty is that too frequently little or no thought or attention is given to the elimination of smoke in starting such fires.

William G. Christy, smoke abatement engineer of Jersey City, N. J., in a paper on Smoke Abatement Problems, presented recently at the meeting of the Smoke Prevention Association at Buffalo, N. Y., told in a very few words how such fires should be started. In the first place, the operation must not be hurried too much. "The best method," he said, "consists in placing enough coal in the firebox not only to start the fire, but also to take the engine out of the house. This should be placed in the grates with a trough in the middle, in which is placed *dry* wood. With this method never more than No. 1 smoke should be made, and not much of that. Using oily waste, oil torches or oil-soaked shavings is bound to make smoke. One advantage of the dry wood method is that one man can take care of three or four fires."

This process may be a bit slower; it may even, under some circumstances, be somewhat more expensive, but it will remove a serious source of irritation to the people who live in the vicinity, and it will mean so much to the added attractiveness of the community that the railroads can well afford to do the job right. We must not forget that favorable public opinion toward the railroads is an extremely important factor, whether considered from the standpoint of securing traffic under competitive conditions, or from the standpoint of getting a square deal from the legislators and regulating authorities. The railroads need friends and no stone should be left unturned to cultivate the good-will of the public.

How Long Can the Railroads Hibernate?

Certain animals, like the bear, go into retirement on the approach of the winter season, seeking refuge in some cave or den where they, in effect, "live on their fat" until the time comes when they can again make a more satisfactory living otherwise. They must accumulate and store away considerable surplus tissue each year, however, prior to embarking on this annual winter hibernation. Can you imagine a lean, hungry old bear, for example, coming out of his winter quarters all set for some nourishing food and suddenly being compelled to return for another protracted period of paw nursing. For how many years could he stand such a program?

The railroads are in much the same position as the animal mentioned. While not actually hibernating, they have been "living on their fat," in so far as equipment maintenance is concerned, for several years. Locomotive and car repair programs have been greatly curtailed, shops closed, personnel reduced, material stocks depleted, and repair parts taken from stored equipment for use of that which must be kept in service. The extent of under maintenance is indicated by the relatively much greater decline in repair costs than in mileage operated. In 1929, for example, equipment maintenance cost the railroads on an average about 101 million dollars a month, this figure dropping to 53 million dollars a month in 1934, or a reduction of 48 per cent. In this same period principal and helper locomotive miles in freight service dropped from about 55 million to 37 million, or only 33 per cent. Similarly, loaded car miles in freight service dropped from about 1.5 billion miles per month in 1929 to .9 billion in 1934, or only 40 per cent.

For several years, now, locomotive and car miles have been run out much faster than they have been restored by repair programs and this trend cannot continue indefinitely. With few exceptions mechanical department officers are undoubtedly doing everything

within their power to get ready for this increased maintenance program. But without more revenue there is no source from which to secure the means to increase maintenance expenditures. The fact that there has been so little actual decrease in the reliability and safety of railway service after four years of drastic retrenchments is a tribute to the self-reliance and resource of the foremen on whose shoulders has fallen the direct responsibility of keeping cars and locomotives in operation.

A Problem of Equipment Design

The design of rolling equipment adapted to meet railway requirements and develop maximum serviceability presents such an intricate maze of conflicting and oftentimes variable requirements that the designer can hardly be said to be resting on any "bed of roses." Nowhere is this fact better illustrated than in the case of automobile cars. These cars, which are designed to carry a high-class commodity and develop correspondingly high potential earnings, are naturally considered a valuable part of railway equipment. When the automobile industry began to turn out its product in quantities in about 1910, many railroads acquired considerable fleets of automobile cars. Generally speaking, the first cars were 40 ft. long and equipped with 10-ft. doors, which at first comprised two 5-ft. doors on each side. To meet shipper demands for easier loading, this door arrangement was subsequently changed on many cars to one 6-ft. door and one 4-ft. door on each side.

As automobiles became larger and the need for capacity loading was stressed, many railroads designed and built 50-ft. automobile cars with heights well up to the clearance limits and equipped with 12-ft. doors, the latter comprising two 6-ft. doors on each side of the car. The next demand on the railroads, and one which has been particularly urgent in the past few years, has been for the installation of automobile-loading devices which permit loading more automobiles per car, provide a safe and reliable means of holding the load, save labor and material costs for blocking and avoid damage to car floors, the latter proving a very serious item of expense. Since the great majority of automobiles now being shipped are of medium or small size and just as many of these units can be loaded in a 40-ft. car as in a 50-ft. car, the present general demand is for the application of automobile-loading devices in 40-ft. cars. What can the railroad do to satisfy these shippers and yet keep its investment in special-purpose cars within reasonable limits?

The dilemma which confronts many roads in this regard is typified by the experience of a western carrier which handles grain primarily but wants to make a little money moving automobiles into the West. Finding its old 40-ft. automobile cars inadequate and unpopular, this road acquired 300 50-ft. automobile cars about seven years ago, these cars being subsequently equipped with an automobile loading device. These cars carry a higher tariff than 40-ft. cars and are not generally satisfactory to automobile shippers at the present time. Consequently they get few automobile loads. Moreover, they cannot be used for handling grain or even packaged cereals and as a result they have hardly turned a wheel during the past 12 months. The road could probably get a few shipments of automobiles provided it had 40-ft. cars equipped with the loading device. Would it be advisable, however, for the sake of such limited automobile business as may be available, for this road to invest in 40-ft. automobile cars with a loading device and thus add some more highly specialized equipment to its inventory?

Railroads, without exception, are keenly desirous of meeting the full requirements of shippers and providing maximum service. The problem of designing and providing equipment to this end is exceedingly difficult with shipper requirements conflicting and variable while, on the other hand, railway freight classification requirements remain inflexible.

Machine Tool Repairs An Important Factor

When those charged with the responsibility of keeping the equipment of the railroad repair shop up to date consider the problem of machine tool replacement they very often overlook one of the most important factors involved—the cost of machine tool repairs. Studies made during the past few years indicate that what is true with many other types of mechanical equipment is undoubtedly also true in the case of machine tools, namely, that the cost of maintaining them in service increases as the age of the equipment increases. As far as the railroad field is concerned sufficient data have not been kept over a period of years to permit the reduction of this factor of machine tool economics to exact figures but enough is known from the experience of other industries to indicate that railroad shops are paying a rather heavy toll on the upkeep of obsolete shop equipment.

In some instances in the industrial field where plants are equipped with tools none of which exceed from 12 to 15 years in age the expenditure for repairs is as low as 1 or 2 per cent on the investment. Figures indicate that the railroads spend from 3 to 6 times as much as this, probably for no other reason than that the average age of machine tools in railroad shops is greater than in most modern industrial plants.

With an investment in shop machinery and equipment estimated to be about 300 million dollars and an annual expenditure for shop machinery maintenance averaging 24 million dollars for the 10-year period ending with 1930 it would seem that here is a condition of sufficient importance to warrant a thorough study on the part of mechanical officers. Modern tools and equipment offer not only the economies of greater productive capacity but a saving in maintenance expense as well.

With the Car Foremen and Inspectors

Welding Details of Milwaukee Coaches

Description of the shop methods employed by C. M. St. P. & P. in construction of light-weight car bodies

A SAVING of approximately one-third was effected in the weight of 52 all-welded steel coaches, built at the Milwaukee (Wis.) shops of the Chicago, Milwaukee, St. Paul & Pacific, as described on page 361 of the October *Railway Mechanical Engineer*. This method of construction and saving in weight, without sacrificing strength, using conventional steel plates and sheets, was made possible by an improved welding process developed by the railroad and utilizing an automatic carbon arc-welding machine especially designed for this job by the Lincoln Electric Company, Cleveland, Ohio. Some of the details of this welding practice not included in the earlier article are described in the present article.

Special equipment used in the welding operations includes, as shown in the accompanying table, one portable automatic carbon arc-welding machine, one portable spot-welding machine, one stationary spot welder, and 11 portable electric welding machines located at various points throughout the shop.

The automatic welding machine comprises a Lincoln Electronic Tornado automatic welding head, Type TA-3, mounted on two parallel cross arms of a carriage which has longitudinal movement over a welding jig arranged to support the individual sheets and parts of the car, side, roof, bottom, etc., in position for welding. The welding head, proper, is guided by a roller on a profile bar which provides for a total up and down movement of 8 in. Cross travel of the welding head, for a total of 14 ft., is obtained by variable-voltage motor drive. The main carriage has a travel of 50 ft. longitudinally, or long enough to cover the entire welding jig. This movement is provided by operation of a hand wheel geared to the carriage wheels which rest on the side rails of the welding jig.

Adequate temperature for welding is obtained by means of an electric arc. The carbon electrode of this arc is maintained, through an ingenious arrangement, at the proper fixed distance above the seam to be welded and revolved slowly to avoid uneven "burn off" of the electrode point. Filler metal is provided by automatic wire feed from a spool on top of the machine, the wire being delivered to a point about ½ in. ahead of the electrode. A paper-covered flux, referred to as a fibrous autogenizer, is also fed automatically to the crater of molten metal, creating a pocket of gas around the weld which prevents the formation of oxides and nitrides in the weld metal. A shielded carbon arc is thus obtained.

Automatic welder in operation

In order to produce uniform welds of superior quality, the Tornado boot is designed to develop a magnetic field around the carbon electrode, and thus steady the arc and avoid what is commonly termed a "wild arc." The resultant weld is not only uniform but free from blow holes, unusually high in tensile strength, ductility and resistance to corrosion. The Tornado boot, which encloses the carbon electrode, is water cooled, and a safety control prevents striking an arc unless the water pressure is on.

A feature developed for this job is the provision of water cooling to localize the heating effects and, when taken in conjunction with the uniformly even bead automatically deposited, provides a smooth external appearance to the car side and roof sheets after welding. The water cooling system consists of an arrangement of perforated pipes located in the welding jig under the steel sheets and designed to throw jets of water upward against the sheets on either side of the weld but without touching it. This method of cooling is sufficiently effective to permit placing the bare hand on the weld within five inches of the arc. Heating of the thin pan sections and warping are thus held to a minimum.

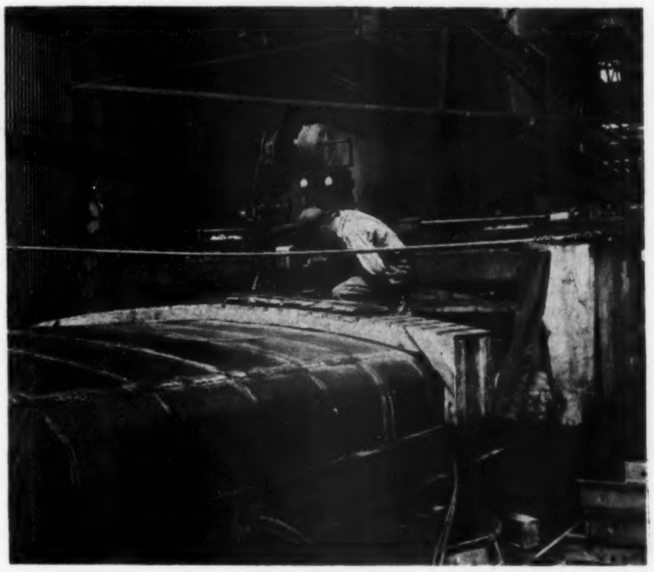
Uncoated $\frac{5}{32}$-in. steel wire, furnished by the Lincoln Electric Company, is used in this welding machine, being carried on the spool above the welding head, as mentioned and shown in one of the illustrations. The paper-covered flux also is carried on another spool, adjacent to the wire spool. All cables, wires and water connections are carried in a flexible 2½ in. Marlin tube suspended by slip rings from a steel cable and light swinging boom as illustrated. This cable is 100 ft. long so as to reach to any part of the shop where automatic welding is required. The entire carriage and welding head

can, therefore, be moved by the shop crane to one welding jig while work is being set up on another.

This machine is operated at Milwaukee shops on three shifts, using one operator and one helper per shift. The helper moves the carriage and welding head from seam to seam by means of the hand wheel, cleans and brushes seams in advance of the welding, applies additional flux when needed, and controls the water jets. He also attends to the adjustment of protective curtains which, it will be observed, are suspended from slip rings on pipe provided around the welding head.

Direct electric current for the automatic welder is provided from a conventional electric-welding machine of 400 amps. capacity which takes 440-volt, 60-cycle, 3-phase current from the shop power line and delivers direct current through a flexible lead to a control box on the automatic welder head. This direct current, as delivered to the carbon electrode, can be varied dependant upon the thickness of the metal to be welded and the welding speed.

In operating the automatic machine when welding car sides, necessary switches are thrown in including the a.c. switch in the Lincoln control box. The water switch is also turned on and the welding head adjusted to the proper height which is approximately 1½ in. above the work. The carriage is lined with the seam and the welding head set at the beginning of the seam with the wire approximately ½-in. ahead of the carbon. As a check to make sure that the a-c Tornado boot is on, the magnetic field is tested by bringing a piece of steel close to the Tornado boot. The paper flux is then set so that it touches the carbon, the ground lead fastened to the middle of the fixture, Grade 100 flux painted on the seams, and the carriage lever lowered. The travel,



Lincoln Electronic Tornado automatic machine as set up, ready for welding a car roof

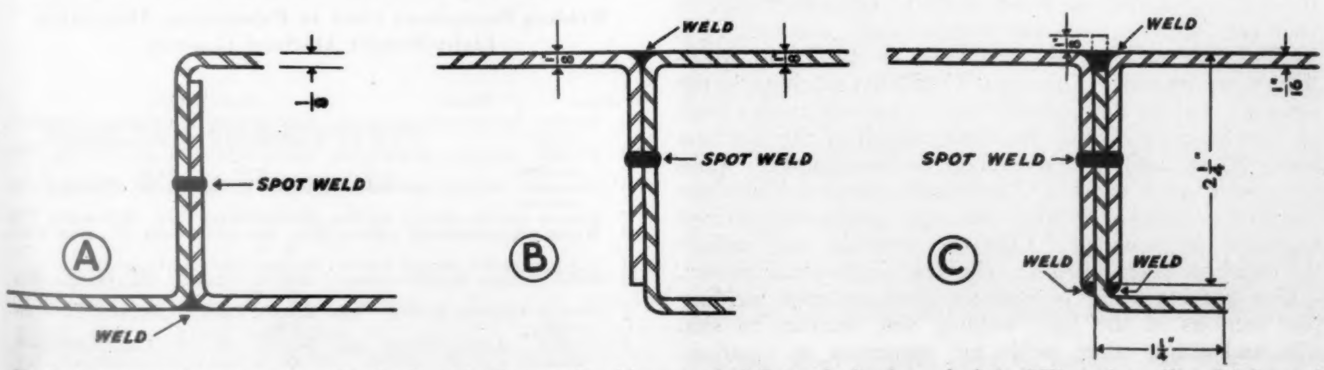
flux and wire feeds, also the arc voltage and current are then set as required. For this work on ⅛-in. side sheet pans, the travel speed is 26 in. per min., the voltage 32 and current 275 amps.

In welding the car bottom, the carriage beam is again set so that the Tornado boot is approximately 1½ in. above the work, the carriage being lined with the seam and the head set at the beginning of the seam. The same procedure is followed as in the case of the side pans with the exception that the travel is 29 in. per min., the voltage 32 and the current 300 amps. In making the lap weld of the Z-section to the bottom, the entire carriage is brought to the beginning of the seam. On this particular seam, filler metal is not used, the lapping sheet furnishing enough metal to make the weld. The travel speed in this instance is 15 in. per min., the voltage 34 and the current 300 amps.

In welding the roof, the beam is jacked up and pins placed in the top holes, the Tornado boot being properly adjusted above the work. The head is lifted and the roll adjusted to ride on the contour of the roof. The starting block is set so that the carbon is at the beginning of the seam and the wire feeder attachments removed since the center sheet at each seam is set high enough above the roof level to provide necessary filler steel for the weld. The seams are cleaned and painted with Grade 100 flux which is allowed to dry completely before starting to weld. In welding the roof seams, the travel is set for 26 in. per min., the voltage 34 and the current 300 amps.

For spot welding the flanges on the car roof, floors

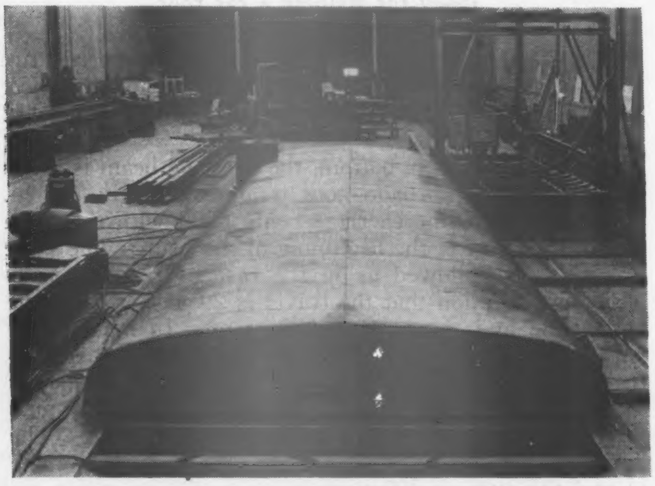
Assembling and tack welding the side pans in a jib preparatory to welding in the automatic welding machine



Typical automatic and spot welds in *A*, underframe; *B*, side pans, and *C*, turtle-back roof of the Milwaukee all-welded coach

and sides as shown at A-B-C in the drawing, a Moesta portable-type air-operated spot-welding machine, made by the Tayor-Winfield Corporation, Warren, Ohio, is used. This machine, with an air-operated head and designed for two-man operation, has a capacity to unite two pieces of ⅛-in. steel by spot-welding. The transformer is rated at 133 kva., and a self-contained regulator gives six current steps. A thumb switch on the air gun handle operates the device. The welding timer, furnished by the Electric Control & Mfg. Co., Cleveland, Ohio, gives automatic adjustable timing for the current. A "No-Beat" device prevents the operator from repeating the cycle until the contactor has released from the previous operation.

In using this welder, the gun is placed with the material between the electrodes; the operator presses the thumb switch, causing the air cylinder to exert pressure, after which the operation is automatically controlled. The gun is then moved to the next position and the cycle repeated. Actual current is on the work for about two seconds. An estimate of production of straight-line work, with spots about one inch apart, is 1,800 to



Completed roof—T-W portable electric spot welder shown in right background—G.E. single-unit welder at the left

3,000 linear inches per hour, dependent upon the thickness and shape of the material being welded. The Equipment includes one set of water-cooled cables, one special air-operated head, one remote control contactor, one E. C. & M. timing unit, and one set of points. The machine, about 2 ft. by 3 ft. by 27 in. in size, is supported by chain falls from a light gantry crane which provides ready hand movement of the spot welder to any point desired on the welding jig. This machine operates on 440-volt, 60-cycle, single-phase current.

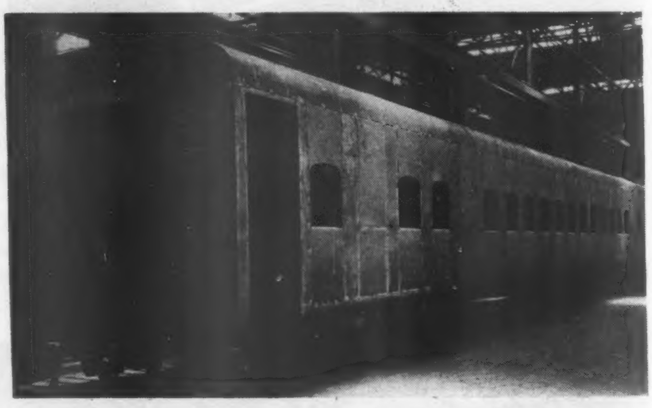
A stationary spot welder, located near the center of the car shop and used for welding reinforcements in roof-pan section and side-pan sections, consists of a U-30-3 spot welder, also furnished by the Taylor-Winfield Corporation. The capacity of this machine is the same as that of the portable type. The electrodes have an overhang of 30 in., the throat depth of the machine being 33 in. and this is enough to accommodate quite a range of work widths. The transformer used with the machine is rated at 28 kva. An eight-step self-contained regulator is provided. Like the portable spot welder this machine takes 440-volt, 60-cycle, single-phase power.

For hand-welding operations, such as spot welding pan sections in the jigs, welding side sections to side sills and many other welds too numerous to mention, a total of 11 portable welding machines are located at various points throughout the shops. In general, these machines will operate on 440-volts, 60-cycles, 3-phase power, taking 200 to 300 amps. Coated wire used in hand welding is of the Sureweld type furnished by the Hollup Corporation, and Airco type furnished by the Air Reduction Sales Company.

The total length of automatic electric welding on the Milwaukee coaches is 1,722 linear ft. per car; continu-

Convenient pneumatic jack used in holding the floor sheet firmly up against the sill and cross-bearers while being welded to them

ous hand arc-welding, 991 ft.; hand-arc skip-welding, 1,444 ft.; and spot welding, 2,378 ft. All welded seams are cleaned and wire brushed with a motor-driven brush to facilitate inspection. Samples of all welding including spot welding are tested and when such samples fail they generally show failures outside of the welds. The welding operators are Milwaukee-trained men who work under one supervisor on each shift.



Car body completely assembled ready for final hand-welding operations

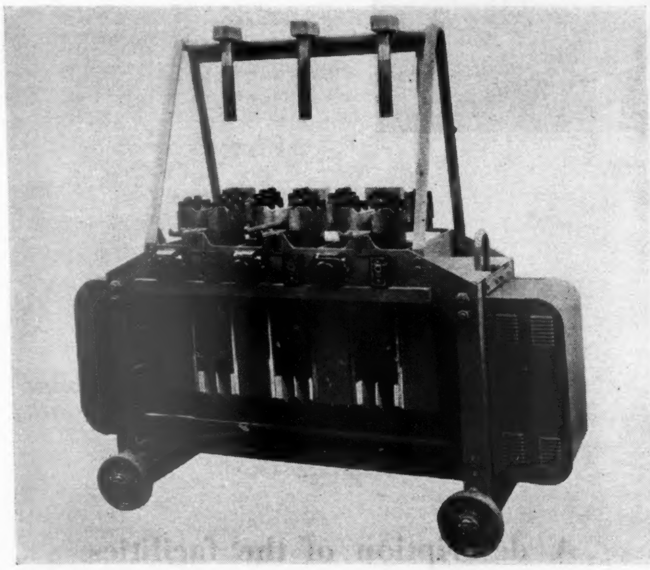
Welding Equipment Used in Fabricating Milwaukee Light-Weight All-Steel Coaches

Number of Machines	Type	Manufacturer
1	Electric Tornado automatic arc-welder	Lincoln Electric Company, Cleveland, Ohio
1	Portable electric spot-welding machine	Taylor-Winfield Corp., Warren, Ohio
1	Stationary electric spot-welding machine	Taylor-Winfield Corp., Warren, Ohio
2	Hanson portable electric welders	Harnischfeger Corp., Milwaukee, Wis.
2	Wilson portable electric welders	Air Reduction Sales Co., New York, N. Y.
1	U.S.L. portable electric welder	Hollup Corp., Chicago, Ill.
2	WD-9 portable electric welders	General Electric Co., Schenectady, N. Y.
1	Portable electric-welding machine	Lincoln Electric Company, Cleveland, Ohio
3	Portable electric-welding machines	General Electric Co., Schenectady, N. Y.

Temperature Control For Electric Heaters

IN the latest designs of the Berwick electric metal heaters manufactured by the American Car & Foundry Company, New York, photocells are used to automatically control the temperature to which the metal is heated.

A photocell is mounted above each of the heating units so that the light from the metal being heated will be projected upon the light-sensitive cell. In operating the heater, a piece of steel is put in the machine and heated to exactly the desired temperature as determined by an optical pyrometer or other suitable means. The photo-electric control unit is then adjusted to control the current supply to the heating electrodes so that the metal will be heated to that temperature. According to tests, the photo-electric unit automatically controls the temperature within a variation of a few degrees.



Berwick heaters are now equipped with photocells which automatically control the temperature

Because the operator is entirely relieved of the necessity of paying attention to the temperature to which the stock is being heated and because of the accuracy of the photocell control, the stock is always heated to the same temperature. Breakage of forging dies because of underheated stock is avoided, and there are no losses from overheated or burned stock.

Another advantage of the electric heating is that less scale is formed, resulting in longer die life and smoother forgings.

Making Oil Drums Into Fire Barrels

By A. Skinner

AT reclamation points where empty oil drums are received from the line, certain of the heavy drums which are in good condition are shipped back to the various oil companies. Other drums, which are made of thin sheets and have been used to ship sticky material like car cement, are cut open, the cement burned out and the metal sold for scrap. Drums of somewhat more substantial construction, which can be satisfactorily cleaned, are taken to the tin shop, the top flanges cut off and the barrels used as water containers for fire protection purposes.

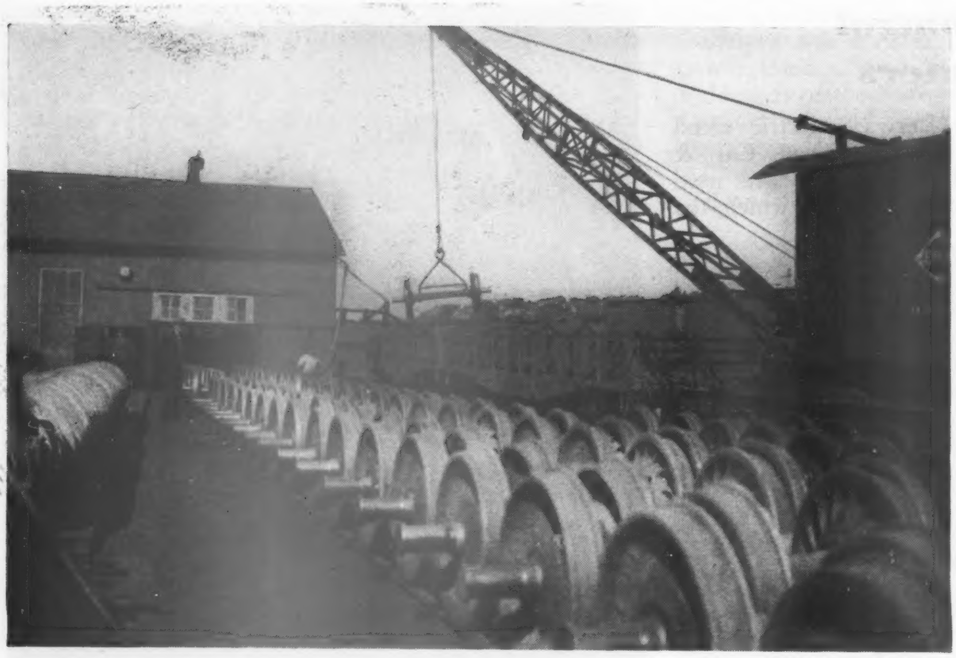
Niagara circular shear as equipped with special brackets to support an oil drum while cutting off the top

One of the earlier methods of removing the barrel tops was to cut them off with an oxy-acetylene torch, but this leaves a somewhat uneven and jagged edge which may cause injury to the hands of men who are handling the barrels. A better method of reclaiming these oil drums for service as fire barrels is to cut off the tops with a circular shear as shown in the illustrations.

The type of shear used is a Niagara No. 216-B circular shear, equipped with a power-operated circular

(Continued on page 452)

Flexible shaft grinder used to remove any sharp edges or burrs from the barrel top



Wheels are unloaded from the car by means of a locomotive crane and placed on the inbound shop track leading to the demounting press

Erie Wheel Shop At Hornell, N. Y.

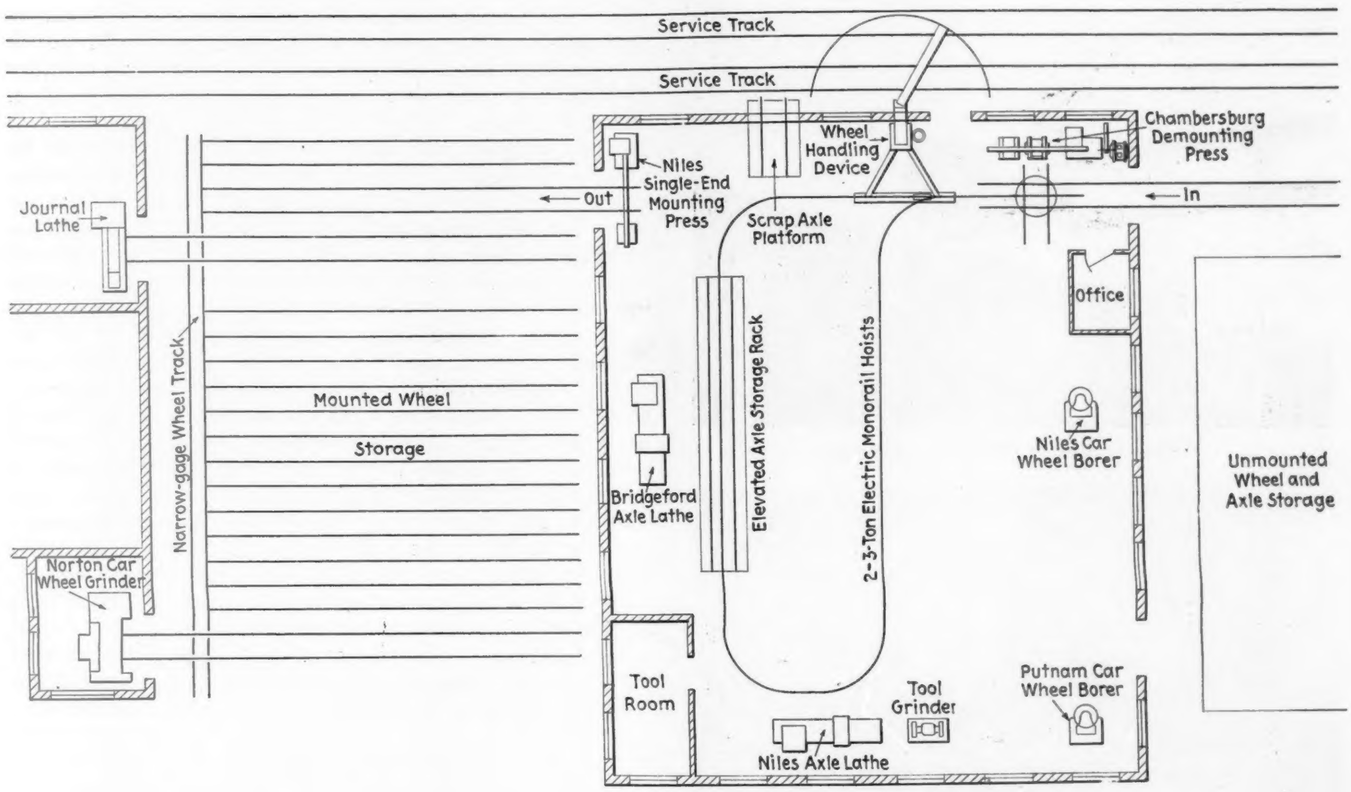
A description of the facilities and shop methods used for handling an average of 2,500 pairs of new and repaired car wheels a month

THE major portion of the wheel work for the western district of the Erie is concentrated at the wheel shop located at the car repair yard at Hornell, N. Y. At this point facilities have been installed for the mounting, remounting, boring and grinding of wheels for freight-car use. This wheel shop has an output of approximately 2,500 pairs of wheels a month under present conditions where the shop is working an average of 16 to 20 days a month.

The general arrangement of the wheel-shop is shown in the accompanying drawings and illustrations. The facilities for performing the various operations and handling the wheels through the shop are shown in the table on the opposite page.

The wheels which are shipped to the Hornell shop from various points on the Erie System are received on the yard service track and unloaded by means of a locomotive crane onto the track leading into the shop. The

Left—Wheels enter the shop near the press and (right) are demounted

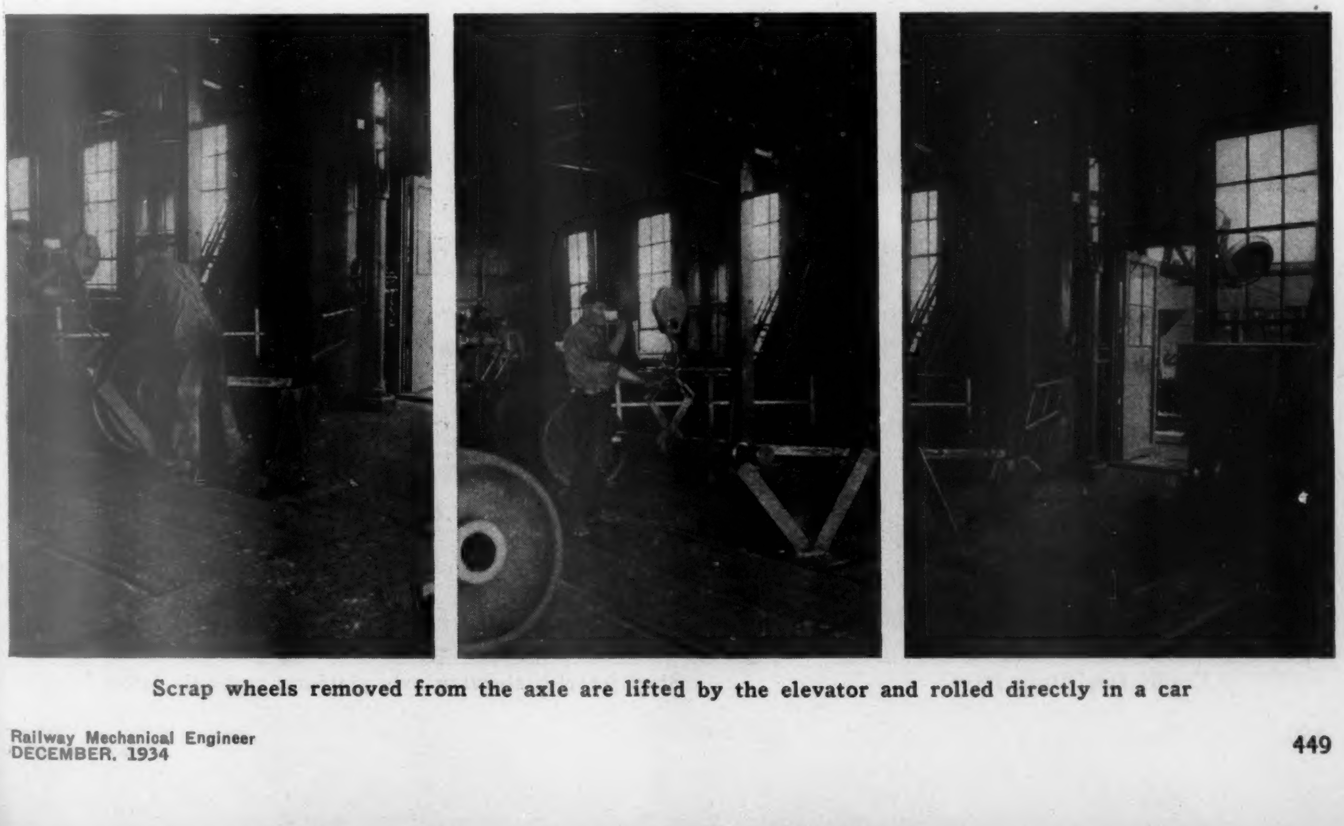


Layout of facilities at the Hornell wheel shop

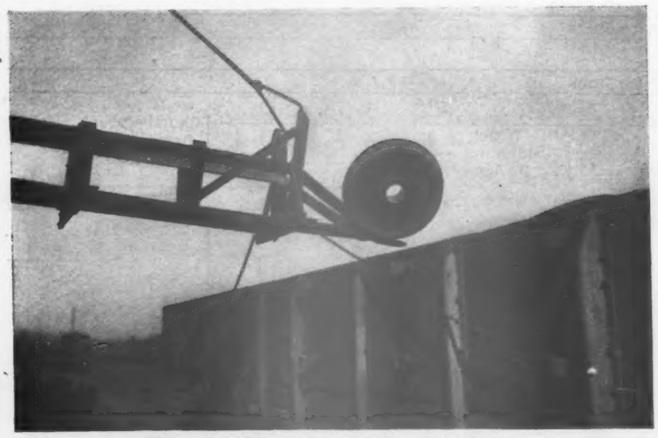
various machines in the shop are so located as to eliminate any unnecessary handling as the wheels pass through the shop in the process of repair. As the wheels enter the shop they are run onto a turntable in front of the Chambersburg demounting press and thence into the machine where protective collars are first slipped over the journals to prevent damage to them as the wheels are pressed off the wheel fit. The demounted wheels, still on the axles, are rolled out of the demounting press and picked up by one of the monorail hoists and moved about 10 ft. to a special wheel-handling device, shown in the illustrations. This device was originally developed at the Erie's Port Jervis Shops to facilitate the handling of wheels destined for the scrap

Shop Facilities at Hornell

1 Chambersburg demounting press	1 Putnam car-wheel borer
1 Niles single-end mounting press	1 Niles car-wheel borer
1 Bridgeport axle lathe	1 Journal-turning lathe
1 Niles axle lathe	1 Norton car-wheel grinder
1 U. S. floor grinder	2 P. & H. three-ton electric hoists



Scrap wheels removed from the axle are lifted by the elevator and rolled directly in a car



Wheel rolling from chute into car

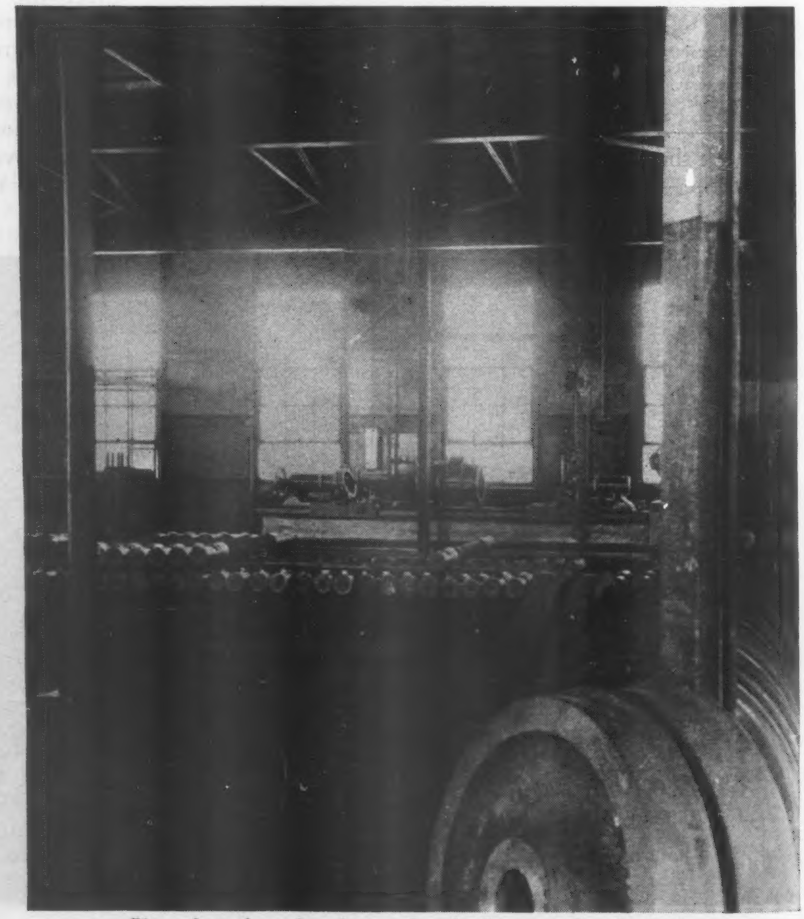
Storage platform for scrap axles

pile. As the illustration shows, it consists of a pair of channeled runways down which the wheels roll, one at a time, into a small elevator which is raised by a cylinder and cable arrangement to a point approximately 10 ft. above the floor. When the elevator has been raised to the proper point the wheel is released and rolls out by gravity through an opening in the side of the building down a swinging chute which dumps the wheels into a scrap car located on the second service track outside the building. After both wheels have been raised and dumped outside in the scrap car the axle is handled by the same hoist to one of two places—either to the axle storage rack in the shop, where they are placed for returning, or on a special rack which is located adjacent to the wheel-handling device for the storage of approximately two dozen scrap axles at a time. Some idea of the value of this wheel-handling device may be gained when it is considered that only about four minutes is consumed in handling a pair of wheels from the time the mounted pair comes into the shop and goes through the demounting press until the scrap wheels are dumped into the car and the axle placed on the rack.

All axle wheel fits and wheel bores are machined to a set of step-size gages in which Kaseberg micrometers and gages are used. The axles, after having gone through the two axle lathes, are marked for identification so that the boring-mill operators are enabled to set micrometer gages to bore wheel fits to accommodate these axle sizes. The unfinished axles are placed at the end of the elevated axle-storage rack opposite the mounting press and the finished axles are placed on the end of the rack nearest the mounting press. New wheels are brought in from the outside wheel storage and placed

Truck for handling scrap axles

Cradle for lifting axles



Shop interior showing axle platform and axle lathe

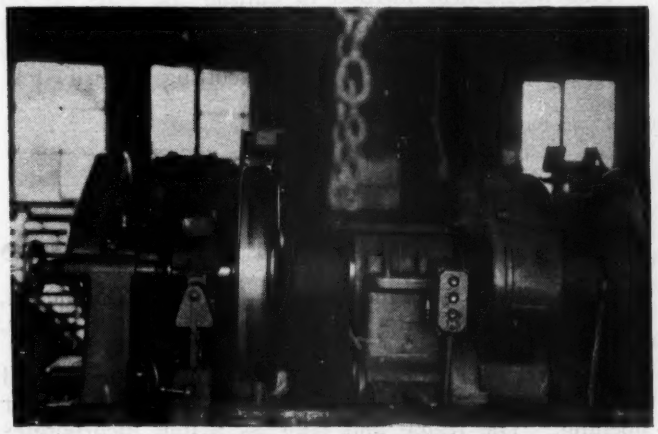
near the boring mill and, after being bored, are stored in the shop at a location near the end of the axle-storage rack on which the finished axles are placed. The operators on the wheel-mounting press take the axles and wheels from these locations and mount them to gage, after which the wheels are rolled out of the shop and either stored in the mounted-wheel-storage space outside the shop or loaded into cars for shipment.

The journal-turning lathe and the Norton car-wheel grinder are located in another building adjacent to the mounted-wheel storage and all mounted wheels requiring either journal turning or tread grinding are placed on storage tracks adjacent to these machines. Wheels are handled transversely across the mounted-wheel-storage tracks on a narrow-gage cross track having a roller-bearing carriage.

Axles which are scheduled to be scrapped are placed inside the shop on the elevated scrap-axle rack previously mentioned and, when a sufficient number has accumulated, a special shop truck, shown in one of the illustrations, is spotted on the track outside the shop adjacent to the end of the axle rack. The axles are rolled out through an opening in the side of the building onto this truck and the truck is moved down the track to a point where the axles can be conveniently handled by the locomotive crane. A special lifting device is used on this crane for picking up seven axles at a time. This device and the method by which it is used are clearly shown in illustrations on this and the opposite page.

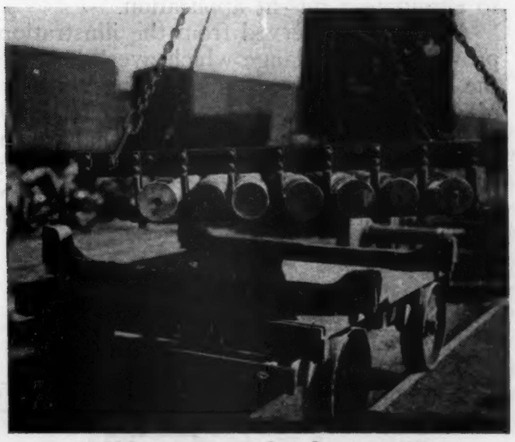
All mounting and mating of rolled steel wheels for this district is done at this shop, but the steel-wheel turning is performed at the locomotive shop, about a mile away from the car shop.

Special tool for truing chuck jaws



Norton car-wheel grinder

Gaging a pair of wheels while being mounted at the press



Lifting scrap axles from truck

Axle cradle with bar in place

Making Oil Drums Into Fire Barrels

(*Continued from page 447*)

cutter and a pair of half round brackets which support the drum at the proper elevation for cutting. These brackets consist of ½-in. by 2-in. flat iron bent to the shape shown and bolted to the bed of the machine. The drum is simply placed on these brackets and the rotary cutter inserted just inside of the top after the cover has been removed. Operation of the cutter then causes the barrel to revolve in the brackets as the top flange is cut off. A smooth, even edge is left on the end of the barrel but, as an extra precaution, a flexible shaft grinder is used to remove any sharp edge or burr which might cut the hand.

This mechanical method of cutting the ends off oil drums to facilitate using the drums as fire barrels has been found to be quicker, more economical and more generally satisfactory than using a cutting torch.

Malleable-Iron Hopper-Car Door and Frame

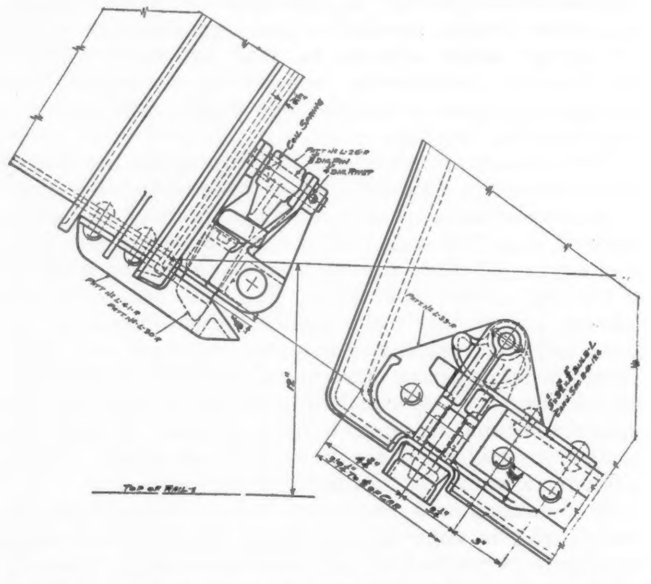
THE Fort Pitt Malleable Iron Company, Pittsburgh, Pa., is offering a malleable-iron hopper frame, door and door lock for railway hopper cars.

The Fort Pitt malleable hopper frame provides a rigid and permanent construction around the entire hopper opening. The frame and door as a unit incorporates hinges and integral door-strap fittings in proper relation to eliminate a mis-fit application.

As will be observed from the illustration, the door is provided with a flange which overlaps the flange around the hopper opening, thus making possible the hauling of pulverized coal and other fine materials reasonably immune from lading loss. The total weight of the unit compares favorably with that of the conventional built-up design. The frame is of four parts: Two sides, one top and one bottom member, riveted together at the foundry to provide a permanent assembly before shipment, thus reducing to a minimum the handling of several parts incident to the built-up design.

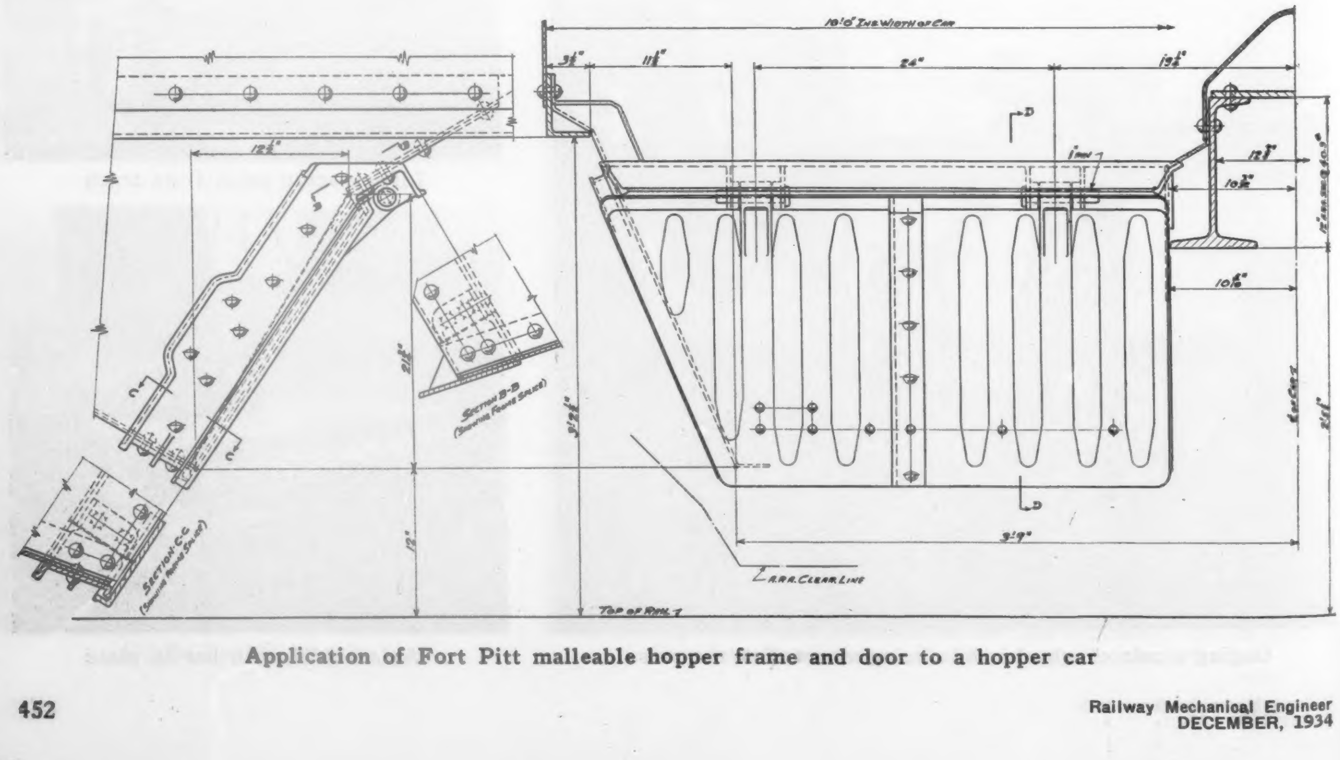
The Fort Pitt malleable positive door lock is designed for safety in operation, strength and simplicity. As a complete unit it consists of only four castings and its total weight is small.

The locking device, being located near the bottom edge of the door in conjunction with the door spreader,



Application of Fort Pitt door lock to hopper car equipped with malleable iron hopper frame and malleable iron door

provides a door stiffener the entire length of the bottom closing edge. This also permits the use of a shorter door spreader than is generally used and reduces the weight about 15 lb. per spreader. In addition, the lock is placed in line with and well above the bottom of the truck side frame, thus maintaining a maximum clearance above the rail line, as well as meeting all other clearance requirements. It is also free from third-rail interference.



Application of Fort Pitt malleable hopper frame and door to a hopper car

The latch assembly is a positive, one-position lock and, when first engaged with the keeper, sufficient clearance between the door and hopper is obtained to allow for any reasonable warpage that may exist in the door. The latch, then driven to its lower position, forces the door home against the hopper opening. The wedge action of the latch holds the door in a tightly closed position, serving also as an automatic take-up for any wear which may develop through use. The latch pawl provides security under all conditions, thus obviating disengagement of the lock due to vibration or otherwise when in rotary dump service.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Method of Repairing Bent Sills on Refrigerator Car—Rule 107

The Central Vermont issued a defect card covering damage to a Fruit Growers Express car. The work done included application of considerable new material, such as sheathing, side door, bunker doors, roof lining, insulation, roof boards, hatchway platform, end ladders, etc., applied in connection with straightening a bent fish-belly center sill and end sill. Bill rendered by Fruit Growers Express amounted to $337.36 and included items which they contended were necessary and involved in straightening the bent sills. The Central Vermont contended that in making repairs a considerable number of items would have been unnecessary had car body been jacked up off underframe and sills then straightened, instead of straightening being performed from inside the car. Under this procedure it was contended repair bill would have been reduced $143.29—the amount in dispute. Fruit Growers Express stated that charges for repairs covered only what was actually necessary in straightening the steel underframe under the most practical and economical method. Method of jacking suggested by Central Vermont was not considered practical and economical as it would be impossible to prevent rods and bolts from turning in attempting to remove nuts and while the nuts might have been split, replacement could not have been accomplished due to corroded threads, consequently it would have been necessary to remove rods and bolts for rethreading or renew them. Method followed and method suggested by Central Vermont were discussed in detail. Bill was received by Central Vermont November 24, 1931, and no exceptions taken until March 31, 1932. Handling was not in accordance with Rule 91 that repair bills must either be passed for payment at once or alleged overcharges brought to attention of company rendering same within 60 days from date bill is received. Repairs enumerated in bill were actually made in accordance with standard shop practice and were absolutely necessary to repair damage that occurred on Central Vermont. In support of contentions reference was made to Arbitration Cases 1060 and 1525. Statement by Central Vermont discussed methods of performing the work and contended that the method followed was not the most economical one.

The decision rendered October 26, 1933, by the Arbitration Committee stated: "The Fruit Growers Express Company followed, in their opinion, the most practical and economical method of making repairs to the damage as covered by defect card of the Central Vermont. There is no prescribed method of procedure specified in the A.R.A. rules to cover the nature of repairs in question, which procedure must be governed by the general design and construction of car. Therefore, the contention of the Central Vermont is not sustained."—*Case No. 1734, Fruit Growers Express Company vs. Central Vermont.*

Wrong Triple Valve Applied—Subsequently Changed by Another Road—Rule 12

The air brakes on a Louisiana & Arkansas car were cleaned by the St. Louis-San Francisco October 12, 1932, and charge for work rendered. The car was delivered to owners October 15, 1932. Air brakes were subsequently cleaned by Missouri Pacific on November 24, 1932 on account inoperative, P2 non-convertible triple valve removed and an A.R.A. standard K2 triple valve applied, charges being rendered accordingly. The St. L.-S. F. refused to acknowledge responsibility for wrong triple valve because car had been on home line between above-mentioned dates, citing Arbitration Decision 1401. Failing to agree, case was submitted for decision. The L. & A. in its statement contended that Rule 12 is intended to protect wrong repairs for a period of 90 days after first receipt of car home. There is no provision that car must not leave home in the meantime; therefore, the St. L.-S. F. is not justified in refusing to issue defect card for wrong triple valve applied. Rule 90 provides that copy of billing repair card of intermediate line standardizing wrong repairs shall perform same function as joint evidence card. There is no record of any wrong repairs having been made to air brakes of this car at home or on any other line between October 12 and November 24, 1932. Arbitration Decision 1401 having been declared obsolete, L. & A. felt justified in claiming protection under Rule 12. The St. L.-S. F. stated that their records showed a K2 triple valve removed and replaced on October 12, car making direct home movement and being delivered to owner October 15, 1932. When brakes were cleaned by M.P. November 24 repair card showed P2 triple valves removed. M.P. repair card was presented to L. & A. in making claim for wrong repairs under Rule 90. Claim was denied on ground that M.P. was not an intermediate line and that their repair card did not perform same function as joint evidence card. Repair card of M.P. is the only evidence owner presented to prove wrong repairs existing. It is contended that a P2 triple valve in place of a K2 valve would have been readily detected in interchange inspection or at some point on owners' rails and that joint evidence should have been furnished in accordance with Rule 12. Since alleged wrong repairs were not corrected before car was delivered home and owner failed to protect with joint evidence, it was contended that claim of L. & A. should be denied.

In decision rendered October 26, 1933, the Arbitration Committee stated: "The contention of the Louisiana & Arkansas is not sustained. Decision 1270 applies."—*Case No. 1735, Louisiana & Arkansas vs. St. L.-S. F.*

In the

Back Shop and Enginehouse

Forged Locomotive Crossheads

During the past year or more the Illinois Central has been securing notably good results with an improved type of forged steel crosshead which is now being used on Mikado, Pacific, Mountain and Central type locomotives operated by this road. The new crosshead is slightly heavier than the former cast-steel type, certain sections, previously subject to breakage, having been enlarged. A feature of the design is the provision of large fillets at all corners. In connection with this crosshead, special floating bronze lateral washers are cut into the inside surfaces of the crosshead cheeks to reduce friction and prevent galling of the main rod front-end.

The forged crossheads are made in pairs from steel billets, specification S.A.E. 1040, purchased in two sizes, 10 in. by 18 in. by 37 in. and 10 in. by 16 in. by 40 in. The first operation is to heat billets of the required size to 1,900 to 2,000 deg. F., after which they are forged under a 1,000-ton press to the approximate shape shown at *A* in the operation sketch. The forgings are then re-heated to 1,000 to 1,100 deg. F., placed on an Oxweld automatic shape cutting machine, and the ends cut out as indicated by the dotted line at *B* in the sketch. Each main forging is then cut in the middle on the Oxweld machine, thus producing two crosshead forgings. The forgings are again heated to 1,900 to 2,000 deg. F., the front end placed in dies under the 1,000-ton press and the wings, or cheeks, spread open as shown at *C*.

The next operation is to heat each forging from 1,000 to 1,100 deg. F., place it on the shape-cutting machine and cut the lead hole for the wrist pin fit, also shaping the back end, as indicated at *D*. The forging is then heated to approximately 1,550 deg. F. and allowed to cool slowly for the purpose of normalizing. All scale is removed by sand blasting, thereby providing a forging which is clean and which can be thoroughly inspected preliminary to machining.

Forged locomotive crossheads ready to be machined at the Paducah (Ky.) shops of the Illinois Central

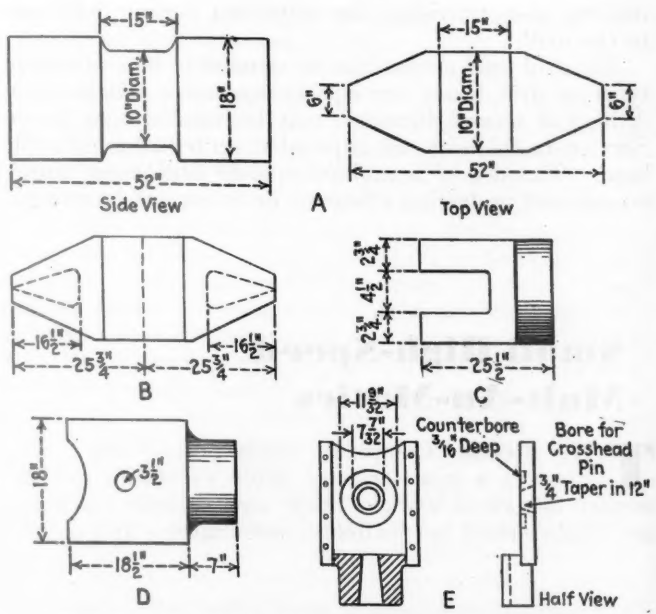
The crosshead is then laid off and carried to an American radial drill press where a 3-in. hole is drilled and subsequently bored for the piston fit. The crosshead ends are faced for length and the front end turned and bored for the piston fit on a Bullard 50-in. boring mill, the taper of the piston fit being ½-in. in 10 in. Outer edges of the crosshead wings are milled, also the insides of the wings milled for the gib fits using an Ingersoll 18-ft. by 56-ft. slab miller. Either four or eight crossheads are machined at one time, using mandrels and V-blocks, as shown in one of the illustrations.

Machining the outer crosshead surfaces, using a special mandrel and V-block set-up on an Ingersoll slab miller

The next operation is to continue the machine work on a Gray 10-ft. by 32-ft. planer. The crosshead wings are planed to the proper thickness for the motion plate. If a motion plate tongue is needed, one is planed on both the top and the bottom side of the outside wing, making the crosshead adaptable to either right or left side application. When it is decided on which side any particular crosshead will be used, the extra tongue is planed off. If a motion plate groove is needed, it is planed when the crosshead is assigned to right or left side use. A ¼ in. radius is planed on the inside of the wings for the gib fits. A special mandrel and V-blocks are used to hold the crossheads during the planing operations.

In the next operation the wings are milled to the proper clearance for the front end of the main rod on a Cincinnati No. 5 Milling Machine. The layout work is then completed, the piston-rod keyways being laid out for either right or left, but not drilled until needed.

A Bullard 42-in. boring mill is next used to bore out the wrist pin holes which have a ¾-in. taper in 12-in. and a ⅛-in. step fit. Both wings are counter-bored on the inside to carry the floating brass lateral liner which is 7¼ in. by 11¼ in. by ¼ in. thick. Each line has twelve ¼-in holes, counter-sunk 3/32-in. deep to serve



Sketches showing various steps in the operation of forging a pair of locomotive crossheads and a general drawing of the crosshead

as grease pockets. This construction is illustrated at *E* in the sketch.

In the next operation, the crosshead is placed in a drill jig and the gib bolt holes drilled and counter-bored on the radial drill press. The dowel pin keyway is drilled, chipped and filed for a ½-in. dowel pin in the wrist pin. The last operation is grinding, filing and polishing a ⅛-inch radius in all sides of the crosshead. All fillets are polished to prevent possible progressive cracks. The average time required to complete a forged locomotive crosshead, made by the method described, is 61.9 man-hours per crosshead.

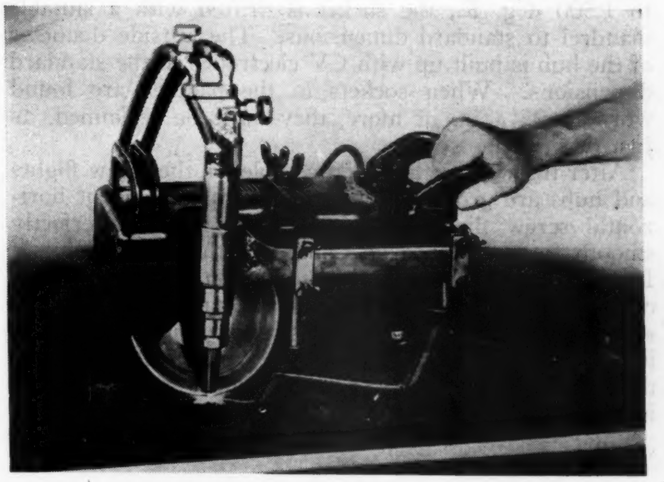
The New Tractograph

THE Airco-DB Tractograph, the latest addition to the Airco-DB line of oxy-acetylene cutting machines manufactured by the Air Reduction Sales Company, New York, is designed to provide a simple means for cutting steel plates and slabs up to 2 in. in thickness accurately into shapes having straight, circular or irregular outlines and extending over practically unlimited areas.

It is a small, compact, motor-propelled unit which can be quickly adjusted to travel at any speed from 2½ in. per min. Its travel is guided by hand along the desired contour laid out directly on the plate or slab. A new drive, combined with other features which enable the operator to change the direction of the machine with exceptional ease, makes it possible to turn sharp corners and follow both simple and intricate contours with accuracy.

The Tractograph will cut beveled as well as perpendicular edges and, with the radius rod in place, will automatically cut arcs or complete circles. Once the operator has set the travel speed, lit the torch and pressed the starting switch, he can confine his attention to guiding the machine. The average mechanic, with a little practice, can follow a line with satisfactory accuracy and, after he has become proficient, can make cuts at much higher speeds than is possible with the hand torch cutting attachments commonly used.

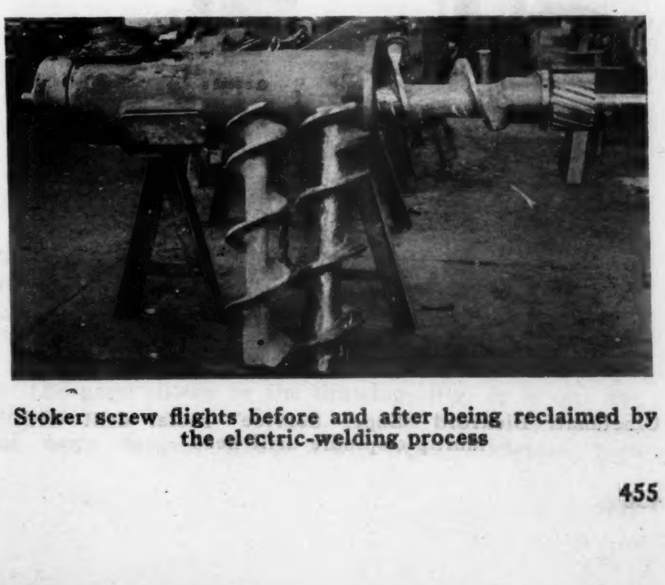
Measuring only 7¼ by 8¼ by 16 in., and weighing but 48 lb., the Tractograph can be easily carried about and used wherever 110 volts, alternating or direct current, are available.


Airco-DB Tractograph in operation

Reclaiming Stoker Screws

IN the reclamation of stoker screws, paddles and clevices, the first operation at the Paducah (Ky.) shops of the Illinois Central is to clean thoroughly all parts by sandblasting. The outside diameter of the flights when worn more than ⅛ in. are trimmed off with the oxyacetylene torch for the application of a ½-in. V-strip, forged from round spring steel or high carbon steel material. Oxidation on the screw flight must be ground off before the application of the strip.

This V-strip is applied by heating, bending and spot-welding, using an oxyacetylene torch. The completion of the welding process is performed by the electric-welding process, using CV electrodes. When the thickness of the flight is 7/16 or less, the flight is built up to standard thickness with CV welding rods, the welded material then being thoroughly cleaned by sandblasting. When the hubs of the flight are worn to 2½ in. or less, they are built up with CV welding rods to 2½ in. outside diameter. They are finished with cast iron welding rods


Stoker screw flights before and after being reclaimed by the electric-welding process

to give a hard exterior wearing surface. The flights are gaged in a lathe and must not be out more than 1/16 of an in. over or under the standard blue-print dimensions.

When the screw sockets on the conveyor screws are worn to 2 11/16 in. or more, they are thoroughly cleaned by sandblasting, preheated to 600 to 800 deg. F., and built up with CV electrodes, then, after being reheated to 1,500 deg. F., the socket is drifted with a suitable mandrel to standard dimensions. The outside diameter of the hub is built up with CV electrodes to the standard dimensions. When sockets in the paddles are found worn to 2 3/16 in. or more, they must be reclaimed, as just described.

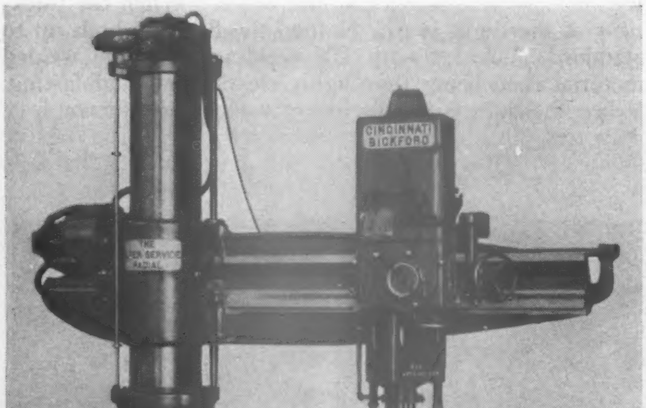
After the welding has been completed, the screw flights and hubs are ground reasonably smooth, the front horizontal screw flights and hubs being ground perfectly smooth for a distance of 4 in. from the ends (points). In all cases, positive polarity is used on the welding machine when cast iron welding rods are being applied, since as much heat as possible is required in welding cast iron by the electric process. All parts reclaimed have the date repaired, make, welder number and operator's initials stamped on the parts.

Multiple-Spindle Drill Heads Used on Radial Drills

MULTIPLE-spindle drill heads for use on radial drills are a recent development of the Cincinnati Bickford Tool Company, Cincinnati, Ohio. A patented self-counterbalancing mounting bracket has been designed which provides rigid support, compensates for the weight of the drill head, and causes its quick return from the work. The multiple head and mounting bracket may be removed in a few minutes, thus quickly converting the machine to a standard single-spindle radial drill.

The illustration shows a 6-ft. Cincinnati Bickford "Super Service" radial drill equipped with a fixed center, ball-bearing drill head to carry three 1¼-in. drills spaced on 2¾-in. centers and each spindle having vertical adjustment. Other drill arrangements may be provided as desired, also provision for supplying cutting lubricant to the drills.

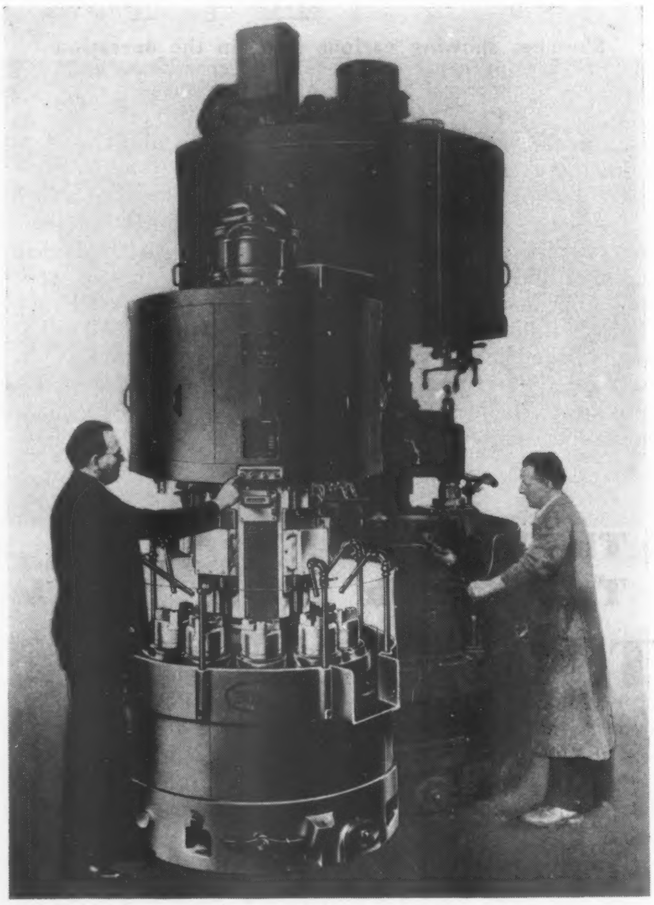
The drill head shown has the spindles in line, but other types of drill heads are equally applicable. Bolt circle drilling of several diameters may be handled on a Super Service radial with an adjustable center distance drill head. The use of a multiple-spindle drill head causes no sacrifice in drilling efficiency or in ease of handling.



Cincinnati Bickford "Super Service" radial drill with multiple-spindle drill head

Small High-Speed Mult-Au-Matics

THE Bullard Company, Bridgeport, Conn., announces a new series of Mult-Au-Matics for the smaller classes of work. These eight-spindle machines are characterized by flexibility, automaticity, and mobility. Series J Mult-Au-Matics are designed for the field of small, high-speed work, and while the two machines, J-7 and J-11, offer all the advantages of the larger machine, they also have many added features. Combined electrical and mechanical functions provide a high degree of flexibility in change-over from one job to another in tool setting and in operation.


Bullard Type J Mult-Au-Matic

Electrification affords three push-button control stations conveniently located for greatest ease and safety of tool setting as well as machine operation. Each control unit has four separate buttons, one for emergency control which stops all functions; a second for starting and

main drive motor; a third for head traverse advance, and a fourth for head traverse return.

Eight spindles allow one station for chucking and seven for work with speeds independently variable to meet the requirements at any station. A wide range of speeds is obtainable. The initial range of the J-7 machine runs in 41 changes from 168 to 1,509 r.p.m. and for J-11 the initial range in 41 changes runs from 84 to 754 r.p.m. In addition, by means of a dual range change feature, it is possible to obtain a blanket 2 to 1 reduction of all spindles. The total maximum stroke is 10 in. The limiting factors of traverse and feed are the minimum traverse stroke of 1⅜ in. and the minimum feed stroke of ¼ in. Control of chuck operation is by means of foot lever conveniently located at the loading station. Rates of feed per revolution range from .004 to .036 in. For work requiring cutting lubricants, a separate easily cleaned unit is obtainable.

Type J eight-spindle Mult-Au-Matics are obtainable in two sizes, known as J-7 and J-11. Their capacities are, respectively, 8 and 12 in. in diameter, with 10 in. for height. The main drive for either machine is 10-hp. motor vertically mounted and direct connected. Traverse motors are, for J-7, 3 hp., and, for J-11, 5 hp. All motors are rated constant speed, 1,760 r.p.m. under full load and may be either a.c. or d.c. to meet plant requirements.

The projected floor space of machines is respectively 50 in. and 58 in. in diameter. The height of both machines from the floor, exclusive of the motors, is only 102 in.

Gages for Wheel Work*

When it is considered that an average railroad operating 100,000 cars and 2,000 locomotives spends about one million dollars a year on wheel work, the importance of proper inspection and gaging becomes evident. It is possible to use some of the present designs of gages in such manner that many wheels are condemned that might remain in service, with safety, a greater length of time.

As an example, consider the gage shown in Fig. 1 used at the present time on most roads for detecting vertical flanges. The accuracy of this gage depends upon the presence of a straight, horizontal portion of the tread, such as is found on a new tire, upon which to place the gage. It so happens that this portion of the tread is no longer straight after the tire has been in service for a month or two. The lack of this straight surface affects the accuracy of the present gage and many wheels condemned for vertical flanges and other defects might be used, with safety, for from one to three months longer. Undoubtedly, the gage used as shown in Fig. 1 is being used properly, but a flange worn as shown in the drawing is impossible without the tread having been worn-hollow. Under such conditions, then, should the gage be dropped down as one would have to do on the worn-hollow portion, it would show a vertical flange long before the flange was actually vertical, assuming, of course, that a flange is not vertical until it is vertical with the bore of the tire; in other words, 90 deg. to the axis of the axle.

The gages shown in Figs. 2 and 3 have been designed by the writer to eliminate some of the shortcomings of the present gages. It is a difficult matter to determine where the wear on the tire is the greatest, whether on the top of the flange as a result of brake-shoe friction; on the outer portion of the tread due to the same cause, or at the center of the tread due to rail wear and shoe friction. How are we to know the actual wear and where it is? Can it be accurately determined with the gages we now have? It is quite possible that one of

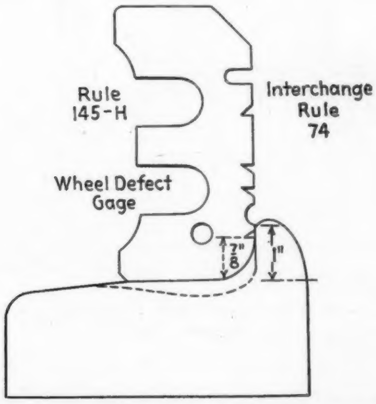


Fig. 1—The A. R. A. gage as used on a vertical flange

the present gages might show an amount of wear insufficient to justify condemning the tire, while at the same time the actual thickness of the tire might be less than it should be. The gage shown in Fig. 2 is used as a test gage to determine wear both of the tire and the brake shoe and has been found to be most reliable because of the fact that it depends upon working from a fixed position, such as the condemning mark on the tire. In using this gage a center mark is placed at the condemning-limit line and another mark above this one at a point on a line drawn radially from the axis of the wheel. The gage is so designed that it uses these two marks as a locator for the gage and, in this manner, the gage is kept square at all times. As may be seen from the drawing, Fig. 2, the wear on the flange,

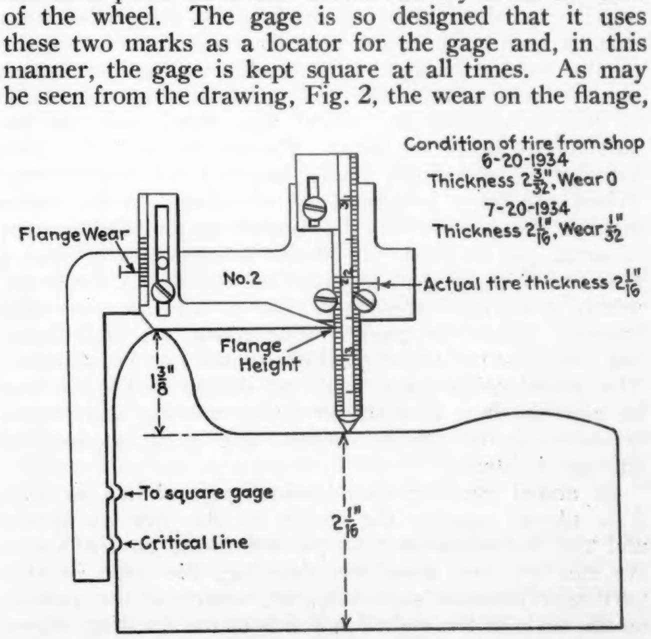


Fig. 2—Test gage used to determine wear of tires and brake shoes

the height of the flange and the actual thickness of the tire may readily and accurately be determined by the use of this gage.

Combination Gage

The gage shown in the drawing, Fig. 3, is one designed for a variety of uses, such as the determination of worn flanges, tread wear, tread thickness, high

* An article submitted by a locomotive inspector who has designed the gages described.

flanges, flat spots, broken flanges, worn collars, broken rims and vertical flanges. It may also be used to check the wear on couplers.

One of the important features of this gage is the fact that it works from the inside of the tire as a base and does not foul the outside of the tread; in other words, the gage is free and always in the same position. If the high portion of the tread, such as shown in Fig. 3, were to be removed when gaging with a standard gage one would notice this error immediately.

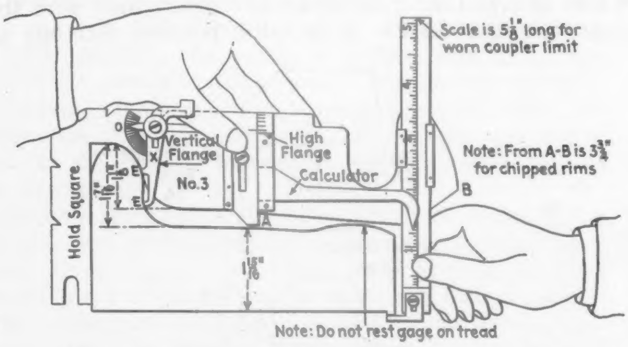


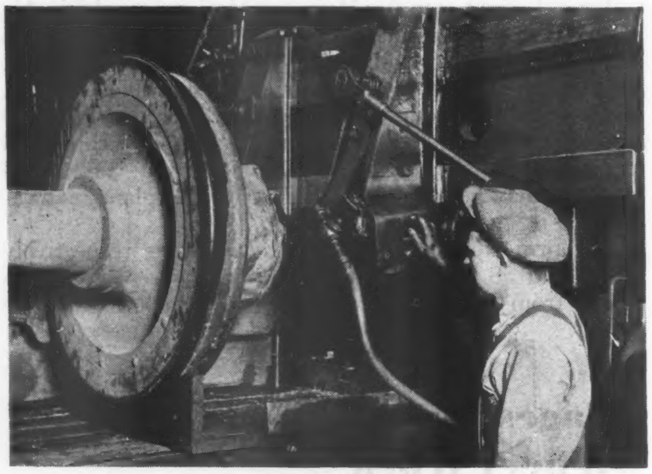
Fig. 3—A gage used for detecting a variety of wheel defects

As an example, consider the case of a locomotive that has been used in a yard with straight tracks and having brake shoes that are worn to the shape of the tread and flange. Say, for example, the thickness is 2 in. Suppose now that this locomotive were transferred to a yard with a considerable number of curves. When the tires are gaged again the usual $\frac{1}{32}$ in. wear and $1\frac{31}{32}$ in. thickness are not found. The false reading is caused by allowing the gage to drop when only surplus metal was worn from the tires on one side of the locomotive owing to the curves forcing the flanges on one side against the rail, while on the other side of the locomotive the wheel was worn only on the outside portion of the tread. The tire on one side of the locomotive, therefore, really has had no actual wear. When the gage is placed on the tread in the usual manner the pointer will be moved up and the amount of wear can be read. It should be remembered that a new tire is tapered to as much as $\frac{5}{16}$ in. on the tread, which overcomes this fault for a few months after turning. Then the gage trouble starts. A high flange can exist under these conditions and not be detected. The combination gage, such as shown in Fig. 3, can be used to show how the tires are wearing and proper remedy can be applied before any great amount of damage is done.

In actual use the combination gage shown in Fig. 3 is placed against the inside of the tire as shown and the calculator arm is pushed down on the tread. As can be seen from the drawing, the gage in this particular instance shows $\frac{5}{16}$ in. wear and the pointer on the scale at the right-hand side of the drawing shows a thickness of $1\frac{5}{16}$ in. without the necessity of any calculations. It should be noted that the scale is adjustable so that it will subtract the thickness of the retaining rim when the tire has one and can be pushed up against the inside of the tire when there is no retaining rim. In measuring vertical flanges the gage is held square and the arm *X* is moved against the flange until the points *EE* strike the flange. The pointer will give a reading of the flange, whether or not it is vertical and how much more wear will be necessary before it is vertical.

Keyways in Booster Axles

On locomotives equipped with tender boosters it is frequently necessary to replace existing crank arms with new cranks and, in the case of one railroad, this required the turning down of the outside end of the axles to a diameter one inch smaller than the original. This, in turn, requires that two new keyways be cut in each end of the axle. Unless special equipment is available for cutting these keyways it presents a somewhat difficult problem which was solved by one machine-shop foreman in the manner shown in the illustration. The mounted wheels were set up on the table of a slab milling machine on a special set of V-blocks. A temporary holder was designed to be mounted on one of the heads on the cross-rail to accommodate an air motor, in the spindle of which an end mill is used. The manner in which this is used is clearly shown in the illustration and the milling cutter is fed by using the table feed on the milling machine. The use of the V-blocks on the table for holding the wheels assures the keyways being parallel with the center line of the axle.



Keyways in tender booster axles are readily cut with this device

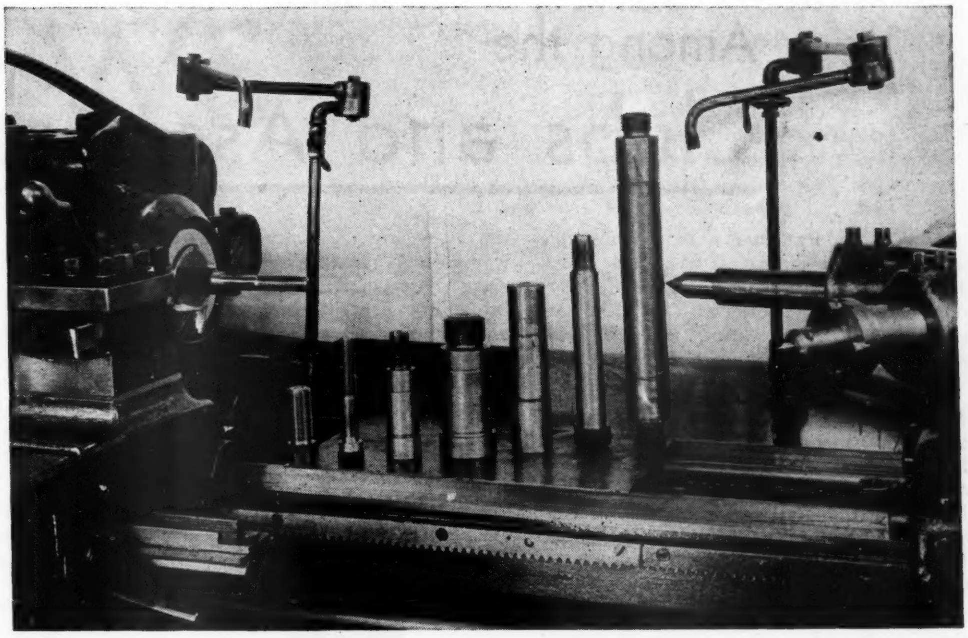
Making Standard Pins and Bushings

*By R. E. Hug**

In recent years, as railway budgets for new shop equipment have been reduced, the problem of machine-tool replacement has become increasingly difficult. In cases where funds are available for the provision of new tools, there is also the question of whether they should be replaced in kind or by some more specialized tools which are capable of higher production and, at the same time, are sufficiently versatile so that they can be kept busy when not used on production work.

For example, locomotive pins and bushings have in the past and, to a certain extent, still are being made on engine lathes. By this method, the pins and bushings are made up for the different parts as needed, and it is necessary to arrange this work in line with the case-

* Production Supervisor, Chicago, Rock Island & Pacific, Silvis, Ill.



Typical standard pins and bolts manufactured in quantities at Silvis Shop. A description of these parts together with dimensions is given in Table I

hardening program. That is, if the casehardening is done at night, it becomes quite a task to have the entire set of pins and bushings ready for one locomotive at a given time. In cases where some parts are not completed, the entire set is delayed another day. The question arises as to how such conditions can be relieved.

The first step in solving this problem at the Silvis (Ill.) shops of the Chicago, Rock Island & Pacific, was to replace a worn-out and obsolete turret lathe with a Warner & Swasey 1A, 2½-in. machine with bar feed and taper attachments. This provided the equipment necessary to turn out the pins and bushings in quantities.

The second step was to eliminate, as far as possible, the old method of making pins and bushings as needed, and incorporate the standardization plan. This was accomplished by selecting a pin which was frequently used and, instead of making only one or two at a time, making them in lots of 50 to 100. The majority of these motion pins have two taper fits, one on each end, and as the parts in which they are used have to be reamed at certain intervals, it is necessary to make step sizes. A set of three gages are used for each pin, the first being for the nominal size of the pin, the second for 1/32 in. oversize and the third for 1/16 in. oversize. These sizes refer to the large diameter of the taper; however, the body size also is made in step sizes to accommodate the increase of the large diameter of the small taper end. The body sizes of all these pins are made .010 in. oversize to allow for grinding and, following the casehardening process, they are ground to size and stored. After a successful demonstration, this standardization plan was extended until 35 different sizes were included covering 92 sizes.

The third step was to standardize the machining of the bushings. These are also made on the turret lathe in large lots from full lengths of steel tubing, while the old method of doing them on a lathe restricted the quantity to one or two at a time. The bushings are bored, reamed and cut off, and stored until they are turned on the outside to fit the particular part in which they are used. It is necessary to provide bushings with corresponding sizes of the pins. After the bushings are casehardened, they are pressed in their respective parts and are then ground to a gage which corresponds with the pin.

With this standardization plan, it is not a burdensome job to prepare a set of motion-work pins and bushings, as the majority of the parts are on hand and can be gathered together quickly. As the locomotive returns to the shop for repairs, the worn pins and bushings are removed and replaced with new. If, however, the parts require reaming, the next size pin is used. The major economy is not in the labor saving made by the quick replacement of parts, but more in the labor saved in making the parts on a systematic basis. It is not unusual to have increases in production as high as 300 per cent.

The turret lathe and several samples of the standard pins and bolts are shown in the illustrations. It will be noted that the first two pieces, shown at the left in one of the views, are not motion-work pins, but are items added to the regular work of this machine to keep it busy. After the plan was in operation for a short period, it was discovered that the machine could be used to make other items in addition to performing the work of two obsolete turret lathes and the major part of the work of two engine lathes.

The operations described are significant because they show that, under present conditions, it is more than ever essential to take advantage of every opportunity to standardize the detail parts of locomotives and produce them in quantities on modern machines at minimum unit cost.

Table 1—Description and Dimensions of Parts Shown in the Illustration

Piece No.	Name	Stock	Length, in.	Diameter, in.	Taper	No. of Operations	Min. Each
1	Side rod keeper bolt	1¼ in. hex.	4	1⅛	None	6	6.5
2	Motor car cap screw	1⅛ in. hex.	5¾	⅞	None	6	11.0
3	Reach rod pin	2 in. rod	6	1¾	2	14	14.5
4	Eccentric rod pin	2¾ in. rod	6¾	2⅝	2	14	20.0
5	Valve rod crosshead pin	2 in. rod	8¾	1⅞	1	11	13.5
6	Link cheek taper bolt	1⅝ in. hex.	9¼	1¾	1	5	10.5
7	Link hanger pin	2¼ in. rod	15¾	2	None	12	18.0

Among the Clubs and Associations

New York Railroad Club.—The sixty-second annual dinner of the New York Railroad Club will be held at the Commodore Hotel, New York, on Thursday, December 13. A reception will be held, at 6:15 p.m., preceding the dinner at 7.

New England Railroad Club.—"Three Mechanical Problems for Solution" is the title of a paper to be presented by W. G. Knight, mechanical superintendent, Bangor & Aroostook, before the meeting of the New England Railroad Club on December 11 at the Copley-Plaza Hotel, Boston, Mass. Dinner will precede the presentation of this paper at 6:30 p.m.

Central Railway Club of Buffalo.—Railroad Terminal Operation will be the subject for discussion at the December 12 meeting of the Central Railway Club of Buffalo to be held at 8 p. m. at the Statler Hotel, Buffalo, N. Y. C. R. Wiseman, general yardmaster, New York Central, will speak on The Yardmaster's Viewpoint; W. H. Sitterly, assistant chief car inspector, Pennsylvania, on The Car Man's Part of the Job; P. C. Berkwater, agent, Erie, The Agent's Side of the Story; M. A. Quinn, master mechanic, Delaware, Lackawanna & Western, The Motive Power Department's Assistance Necessary, and William J. Sheridan, assistant general freight agent, Baltimore & Ohio, on The Traffic Man. Officers for 1935 will be elected.

Association of American Railroads.—Further progress in the organization of the new Association of American Railroads was taken when the board of directors met in Washington on October 31 and elected additional officers, although three vice-presidents are still to be elected. The executive committee also held a meeting but made no announcements. J. J. Pelley, president of the association, has taken up his headquarters at Washington. ¶ M. J. Gormley, since April 1, 1933, president of the American Railway Association, was elected executive assistant to the president; James R. Downes, assistant vice-president of the Pennsylvania, was elected vice-president in charge of operations and maintenance; Harold J. Forster, secretary and treasurer of the American Railway Association, was elected secretary and treasurer of the new association, and Stanley J. Strong, secretary and treasurer of the Association of Railway Executives, was elected assistant secretary and treasurer. Fairman R. Dick, a member of the investment firm of Dick & Merle-Smith, of New York, was appointed advisor on finance and credit. The vice-presidents yet to be named are for the traffic, finance, and planning and research departments. ¶ The department of operations and maintenance is to deal with all matters pertaining to operating, car service, transportation, equipment, telephone and telegraph, signaling, maintenance and construction engineering, mechanical, purchases and stores, inspection, freight claims, and such other matters of a related nature as may require attention or referred to it by the president.

James R. Downes

Car Foreman's Assn. of Chicago.—J. A. Deppe, assistant superintendent car department, Chicago, Milwaukee, St. Paul & Pacific, will present a paper on the Preparation of Freight Cars in Terminal Yards for Road Haul before the meeting of the Car Foreman's Association of Chicago to be held at 8 p. m. on December 10 at the LaSalle Hotel, Chicago. ¶ At its meeting on Monday evening, November 12, the Chicago Car Foreman's Association introduced the innovation of devoting its entire meeting to a discussion of questions bearing on the work of car-department supervisors and inspectors. Among the subjects discussed were rusty journals—stored cars; shopping loaded cars on account of worn brake attachments; dust guards; application of split keys, cotter keys, etc.; elimination of running defects; journal bearings—loaded cars—packing "in date"; packing—exchange of wheels—unit frame; side carding cars—pivoted machinery; inspection pits. In discussing these subjects and questions the members expressed their opinions freely and obtained a much clearer understanding of many of the controversial questions raised.

Western Railway Club.—Meeting held Monday evening, November 19, at Hotel Sherman, Chicago. Subject "The Freight Car" by V. R. Hawthorne, secretary, Association of American Railroads, Mechanical Division. ¶ Regarding certain recent suggestions for the freight car of the future, particularly as regards weight, Mr. Hawthorne said that developments already made in light-weight materials will permit a load-carrying ratio of five to one in cars of otherwise conventional design. Regarding small cars of special design, Mr. Hawthorne pointed out their limitations and particularly the fact that while present small-lot shipments would seem to favor the use of relatively small cars, the ratio of deadweight to load-carrying capacity is high in this type of car and, moreover, since freight equipment has an effective service life of two decades or more cars must be designed for average needs during this extended period and not solely for the needs of the moment. ¶ Mr. Hawthorne explained that, while shippers doubtless prefer numerous door openings for greater ease of loading and unloading, from the point of view of equipment design and maintenance, door openings should be restricted in number to those absolutely needed. ¶ In connection with the all-purpose car Mr. Hawthorne stated that, while this type of equipment may be desirable from the point of view of utilization and to reduce empty car mileage, this advantage is largely theoretical and that, in reality, a car designed to handle all kinds of commodities would be unsatisfactory for the shipment of any one. Mr. Hawthorne concluded his paper with the statement that freight containers and container cars may prove to be the best means of meeting small sales unit shipping requirements, provided designs can be worked out which are practicable and will fit into the complete scheme of transportation service which railroads are now endeavoring to provide.

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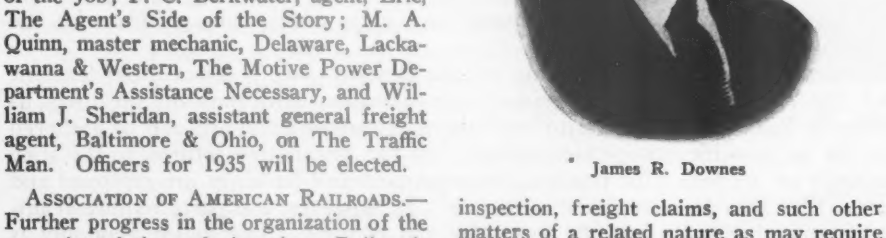


The New York Central's Streamlined Locomotive

It is believed that the streamlining of this Hudson, whenever the locomotive is operated at speeds of 70 to 90 m.p.h. or more, will effect a decrease in head air resistance of 35 to 36 per cent, which is expected to be reflected in a saving in fuel. Several other beneficial features are also claimed for the new design. It provides additional insulation for the cylinders, auxiliary apparatus and pipes, thus helping to protect them from freezing temperatures. The 79-in. drivers are also equipped with roller bearings.

NEWS

Diesel Engineering Handbook—A Correction

In the review of the Diesel Engineering Handbook given on page 404 of the November issue of the *Railway Mechanical Engineer* the number of pages in the book was incorrectly stated as 32. The book contains 320 pages.

Mechanical Division Letter Ballot Results

The recommendations of various committees presented at the meeting of the Association of American Railroads, Mechanical Division, held in Chicago, June 27, 1934, were submitted to letter ballot, the detailed results of which have just been made available in Circular DV-821. The committee recommendations, totaling 93 in number, were all acted upon favorably. Proposed amendments to the Standard and Recommended Practice of the Division were approved effective March 1, 1935, and amendments to the Interchange Rules and Loading Rules of the Division were approved effective January 1, 1935.

AB Brake Mandatory After 1944

The Board of Directors of the Association of American Railroads on November 16 adopted the recommendations of the General Committee, Mechanical Division, to provide that on and after January 1, 1945, all freight cars in interchange must be equipped with the AB brake. This action follows the adoption, by a vote of more than 80 per cent of the letter ballots cast, of the proposition to modify section (a), paragraph 4, Interchange Rule 3, to require that all cars in interchange service on and after January 1, 1945, must be equipped with brakes meeting the requirements of the A.R.A. specifications for air brakes adopted in 1933. Quarterly reports, showing the number of freight cars acquired and the number of freight cars on which brake equipments have been converted each month, are to be made by the railroads to the association.

Export of Locomotives and Cars for Chile

The largest export shipment of railroad equipment since the beginning of the depression was made by the Baldwin Locomotive Works and the Bethlehem Steel Export Corporation at the Baldwin docks near Chester, Pa., on November 16. The shipment consisted of 10 locomotives, 10 tenders and 15 first-class passenger cars for delivery to the Chilean State Railways.

Don Manuel Trucco Ambassador of Chile, received the equipment on behalf of his government. Robert S. Binkerd, vice-president and director of sales of the Baldwin Locomotive Works, and S. M. Bash, vice-president of the Bethlehem Steel Export Corporation, conveyed greetings for American industry. The affair was followed by a dinner to the ambassador and to the consular officials representing Latin American countries.

P. R. R. Shop Employees Organize

Representatives of the Pennsylvania's shop crafts employees, at a recent meeting in New York, organized a new association which it is contemplated will become affiliated with the recently-organized Brotherhood of Railroad Shop Crafts of America. The latter, which was formed last July, as reported in the October *Railway Mechanical Engineer*, is a new shop-crafts labor-movement, having no connection with the American Federation of Labor and designed to afford railway shop employees an opportunity to conduct their affairs independently of the latter.

The newly organized unit of P. R. R. employees elected the following officers: President, T. H. Davis, Woodlyne, N. J.; system vice-president, E. W. McClain, Harrisburg, Pa.; system secretary-treasurer, Paul Reese, Ft. Wayne, Ind. Mr. Davis is also national organizer for the Brotherhood of Railroad Shop Crafts of America. The delegates at the New York meeting also appointed a system negotiating committee to meet with the Pennsylvania management for the purpose of formulating a set of rules, working conditions and rate schedules for shopmen. They further voted to establish a system board of adjustment for the settlement of grievances.

Mediation Board Certifies Employee Representation

Following elections of shop employees the National Mediation Board has issued the following certifications:

On the Spokane, Portland & Seattle the Railway Employees' Department of the American Federation of Labor has been duly designated and authorized to represent the crafts of machinists, boilermakers, blacksmiths, sheet metal workers, firemen and oilers, and their helpers and apprentices.

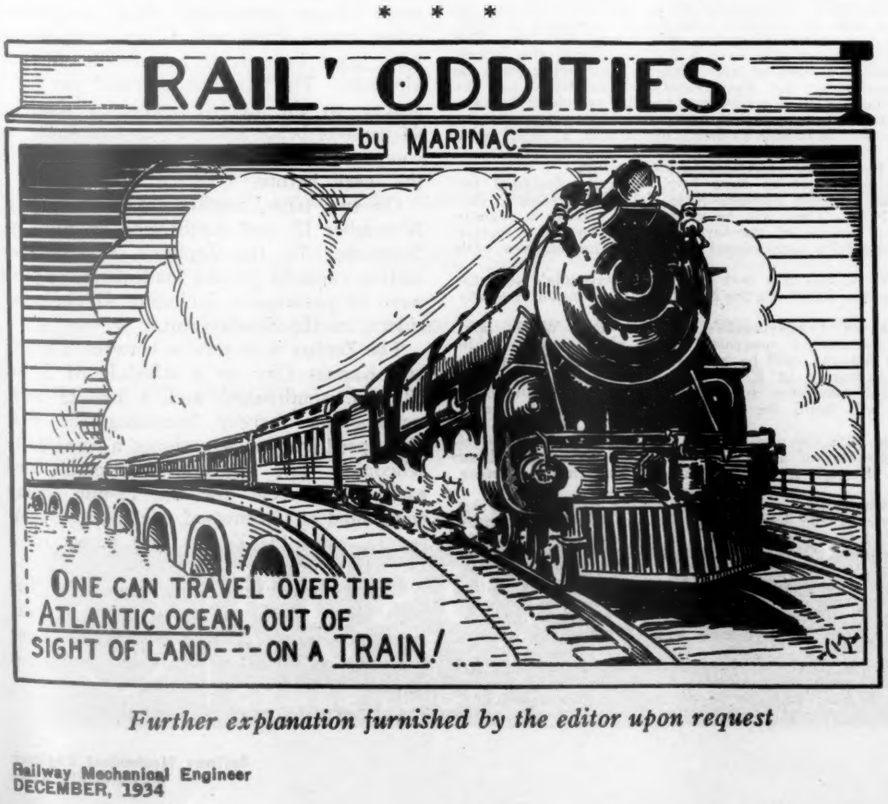
On the Great Northern the Associated Organizations of Shop Craft Employees has been designated to represent the crafts of electrical workers, carmen, and their helpers and apprentices.

On the Atlantic, Birmingham & Coast the board has certified that the Metal Trades Crafts Association, Atlanta, Birmingham & Coast Railroad, has been authorized to represent the machinists, boilermakers, blacksmiths, sheet metal workers, and electrical workers and their helpers and apprentices, and that the Association of Car Employees has been authorized to represent the carmen, and their helpers and apprentices.

Eastman Investigates Sale and Handling of Scrap

On October 26, 1934, the Federal Coordinator of Transportation addressed to the railroads an inquiry prepared by his Section of Purchases concerning the handling and sale of scrap. The purpose is to develop information on: (1) The costs of handling and preparing scrap for the market and the net revenue accruing to the railroads through the sale of scrap; (2) the advantages and disadvantages of dismantling equipment versus sale "on wheels," or dismantling by outside agencies; (3) the possibilities for economy through the establishment of central scrap plants to serve two or more roads, and (4) the relative position of the railroads as scrap producers.

* * *



Further explanation furnished by the editor upon request

The inquiry will develop information on the total amount of scrap originated by the railroads for the five years, 1929 to 1933; the amount shipped direct from point of origin and the amount handled through scrap sorting plants, for both ferrous scrap and non-ferrous metal scrap. The amount of each class of prepared scrap shipped during 1933 and the market into which it moved will be determined, together with the money received for the scrap. Because of the effect of freight haul on price, the ton-miles of haul, both free and revenue, and the freight revenue received are given due place in the inquiry.

The number of locomotives and cars dismantled, sold "on wheels" and sold under other agreements, together with total weight, terms of sale and money received, is also requested.

"There is wide variation in what meager information is at present available on the cost of scrap plant and dismantling operations," Mr. Eastman said. "The inquiry contains well defined questions dealing with those items which will secure figures on the individual features of cost and will develop comparable figures. From the returns as a whole, it will be possible to place before the railroads a more complete and authoritative picture of their scrap handling operations than has ever been available, and one which will provide the basis for a concerted attack on many problems, the solution of which should result in improved efficiency."

Details, such as locations of scrap plants, size, capacity, facilities used, and kind of operations performed in each, will also be covered by the inquiry.

New Equipment

Car Orders

Road	No. of cars	Type of car	Builder
Ill. Central	1[1]	5-car artic. train	Pullman Car & Mfg. Co.
Mesta Machine Co.	2[2]	100-ton flat	Std. Steel Car Corp.
	2[2]	100-ton gondola	
Mexican Ry.	30	40-ton box	Pressed Steel Car Co.
	20	Automobile	

Car Inquiries

Road	No. of cars	Type of car	Builder
D. & R. G. W.	2 to 4	Dining	....
Minnesota Mining & Mfg. Co.	25 to 100[3]	70-ton hopper	....
Nov. Pac.	24	Light-weight de luxe coaches	....

Locomotive Orders

Road	No. of locos.	Type of locomotive	Builder
A. T. & S. F.	1	3,600 hp. Diesel-elec.[4]	Winton Engine Co.
Ill. Central	8[5]	Diesel-elec. switch	American Loco. Co.
	1[5]	Diesel-elec. transfer	Busch-Sulzer Bros. Diesel Engine Co.
	1[5]	Diesel-elec. transfer	Winton Engine Co.
	1[5]	Diesel-elec. transfer	Ingersoll-Rand Co.
Pennsylvania	57	Electric	See Note 6.

Miscellaneous Orders

Road	Type of equip.	For use on	Order placed with
Boston & Maine	Jour. bear. and boxes	New streamlined "Flying Yankee"	Hyatt Roller Bearing Co.
	Isothermos journal boxes	See Note 7.	Nat'l Malleable & Steel Cast. Co.
Grand Trunk Western	Engine truck bearings	4 pass. locos.	Timken Roller Bearing Co.
Ill. Central	Auto loaders	400 auto cars	Evans Products Co.
N. & W.	Loco. valve pilot	1 frt. loco.	Valve Pilot Corp.

[1] This five-car, streamlined, articulated, Diesel-electric, Cor-Ten steel passenger train is intended for use between Chicago and St. Louis, Mo., and will operate on a schedule of less than five hours, making a round trip daily. The train, which will be built in the Pullman shops at Chicago and which will cost $400,000, will be delivered next spring. The train, which will weigh 250 tons loaded and which will have an overall length of 330 ft., will replace two six-car steam trains weighing 601 tons with locomotive and tender. It will be propelled by a Winton Engine Company 1,200-hp. Diesel-electric engine for which the electrical equipment will be furnished by the General Electric Company.

The five cars, all of which will be air-conditioned and which will have a seating capacity for 150 passengers, will include a motor car, a baggage, mail and express car, two chair cars and a lounge car. Cor-Ten steel, a product of the United States Steel Corporation, will be used in the framework, while aluminum will be used in the remainder of the body and for the interior finish.

One of the distinctive features of the train will be its provision for dining service. An electrically-equipped kitchen in the lounge car will supply meals to dining tables located in that car and to seats in the chair cars, each of which will have a collapsible table.

[2] To be equipped with Timken roller bearings.

[3] Contemplated; inquiry not placed.

[4] Four power units of 900 hp. each. This locomotive will be used in pulling the "Chief" between Chicago and Los Angeles, Cal.

[5] These 11 locomotives constitute one of the largest orders ever placed for Diesel-electric locomotives and represent one of the major steps in the progressive elimination of steam operation on the Chicago terminal of the Illinois Central in accordance with the so-called Lake Front ordinance of 1919. The eight switchers to be built by the American Locomotive Company will be of 600 hp. The transfer locomotive to be constructed by the Busch Company will have a 2,000-hp. unit, the largest single motor yet ordered for railway service, while the remaining two transfer locomotives will be equipped with 1,800-hp. units. The electrical equipment for the transfer locomotives will be furnished by the General Electric Company, while the electrical equipment for the switching locomotives will be furnished by the Westinghouse Electric & Manufacturing Company. The contracts for this equipment, which will cost $1,200,000, provide for deliveries to begin on March 1, 1935, with completion by mid-year.

[6] This is one of the largest locomotive orders in the history of American railroading.

Costing almost $15,000,000, these new streamlined electrics have been specially designed for Pennsylvania's high speed passenger service to be inaugurated between New York, Philadelphia, Pa., Baltimore, Md., and Washington, D. C., early in 1935. They will be capable of making a regular operating speed of 90 miles an hour, and will haul trains of standard size and length. Twelve 57-in. driving wheels, six on each side, will drive the fully streamlined articulated locomotives with the full power of 4620 hp. at high speed.

The purchase is being financed through the P. W. A. and is a part of the Pennsylvania's seventy-seven million dollar improvement and equipment program, involving the New York-Washington roadway electrification and car and locomotive construction.

Eighteen complete locomotives will be built at the Pennsylvania's Altoona, Pa., Works, and the works also will apply the electrical propulsion and control apparatus to the chassis of 25 additional locomotives. The 25 chassis to be equipped at Altoona, will be built at the Baldwin Locomotive Works at Eddystone, Pa. The General Electric Company at Erie, Pa., will build 14 complete locomotives and the electrical propulsion and control apparatus for 9 others. The Westinghouse Electric & Manufacturing Company at Pittsburgh will build the electrical propulsion and control apparatus for 34 locomotives.

Each locomotive will cost in the neighborhood of $250,000 and will be 79½ ft. long, of all-steel construction and will weigh 460,000 lb. It will operate on an 11,000-volt, 25 cycle, single-phase system, the current to be fed by overhead wires through a pantagraph. Its maximum starting tractive effort will be 72,800 lb.

Two main frames, each resting on six driving wheels and a four-wheel engine truck, joined by an articulated or hinged joint, will support the body of the locomotive. Power will be furnished by six pairs of twin traction motors, each pair attached to a driving axle. Power will be transmitted to the driving wheels through quill mounted gears, permitting the free spring play of axles and wheels.

The new locomotives will form part of the Pennsylvania's fleet of more than 150 electric locomotives designed specially for the New York-Washington passenger and freight service. This is the second extensive locomotive order placed by the Pennsylvania in recent months. In July, the company placed orders to proceed with the construction of 28 electric passenger locomotives at a cost of over $6,000,000. Work on these locomotives is progressing rapidly, and they will be placed in service in the near future.

[7] For use under the tenders for the five new Pacific passenger locomotives now being built by the Lima Locomotive Works; five tenders of the Mountain type locomotives for freight and passenger service, now being built by the Baldwin Locomotive Works; and for 10 de luxe coaches now being built by the Pullman-Bradley Car Corporation.

Zephyr Increases Business

THE Zephyr of the Chicago, Burlington & Quincy carried more than 100 persons on its first scheduled run between Lincoln, Neb., and Kansas City, Mo., on November 11. The demand for space in the 72-seat capacity train was so great that reservations were closed several days in advance when requests amounted to several hundred. In order to provide for holders of through tickets, the sale of tickets from Lincoln and Omaha was limited to 50.

Omitting the patronage of the train on the first day when its inauguration was attended with special ceremonies, 35 per cent more passengers rode on the train during the week of November 12 to 18 than had ridden the steam-drawn train in the preceding week. The average patronage between all points was 91 persons, as compared with 67 on the former train. A questionnaire given to passengers returned figures showing that 18 per cent traveled from curiosity; 67 per cent would have used Burlington steam train service anyhow, 10 per cent would have used some other steam train and 5 per cent would have gone by private automobile, bus or airplane. The distance traveled per passenger on the Zephyr increased sharply, 44 persons being carried per train-mile as compared with 21 persons per train-mile the week before.

On two trips, southbound on Saturday, November 17, and northbound on Sunday, November 18, the Zephyr's 72-passenger seating capacity proved inadequate. There were 90 passengers, including 41 curiosity riders, on the Sunday run.

The Zephyr is in service between Lincoln and Kansas City on a schedule of 5 hr. 30 min. southbound and 5 hr. 25 min. northbound, thereby becoming the first high speed train to be assigned a fixed daily schedule. The schedule was maintained each day, except for the 15-min. delay westbound at Greenwood, Neb., on November 13, when the Zephyr was struck by a farmer's truck.

The gross revenue per train-mile has been about $1.65, of which about $1 was from passengers, compared with passenger revenues of about 50 cents on the steam trains.

(Turn to next left hand page)

Supply Trade Notes

Louis M. Shine has been appointed railway sales manager of the Standard Varnish Works, with offices at 386 Fourth avenue, New York City.

Francis D. Bartow was elected a member of the board of directors of the General Electric Company at a meeting of the board on October 26.

The Henry J. Linn Company, 250 Stuart street, Boston, Mass., has been appointed New England sales agent for the Globe Steel Tubes Company, Milwaukee, Wis.

Ralph R. Weddell, consulting engineer, has become identified with the Ingersoll Milling Machine Company, Rockford, Ill., in charge of the design and sale of small tools.

Maurice E. O'Brien and Moxie S. George have entered the employ of the Inland Steel Company as salesmen, the former in the Chicago office and the latter in the Milwaukee, Wis., office.

Robert J. Working, assistant district sales manager of the Republic Steel Corporation, with headquarters at Cincinnati, Ohio, has been appointed district sales manager, with the same headquarters, to succeed W. A. Peck.

A. P. Marwick, who was formerly in the sales department at Chicago, of the Taylor-Wharton Iron & Steel Company, High Bridge, N. J., has been appointed sales manager of the Burnside Steel Foundry Company, Chicago.

Oster-Williams Company of Cleveland, Ohio, manufacturers of pipe and bolt-threading equipment, have opened an office and display room at 292 Lafayette street, New York, in charge of H. B. Van Osten, district manager. All machines will be available for actual threading demonstrations.

Charles H. Reinert, formerly superintendent of the Brooklyn plant of Steel and Tubes, Inc., has become asssitant superintendent of the electric weld tube mill of the company at Youngstown, Ohio. M. B. Steel, until recently a sales engineer working out of the Cleveland office of Steel and Tubes, Inc., is now assisting E. T. Glass, sales manager of the New England division, at Boston, Mass.

Russell E. Colgate, chairman of the board of the Tyson Roller Bearing Corporation, Massillon, Ohio, has been elected president and treasurer succeeding Charles E. Stuart, who has resigned as president and treasurer, but will remain on the board of directors. Ralph H. Maxson is executive vice-president in charge of operations; George C. McMullen, vice-president in charge of sales; George Neupower, secretary, and E. R. Ernest, assistant treasurer and purchasing agent.

The American Rolling Mill Company, Middletown, Ohio, has established a new sales office in the Citizens and Southern National Bank building, Atlanta, Ga. C. M. Broome, Jr., is assistant district manager in charge of this office. The new Armco sales office will serve the states of Florida, South Carolina, Alabama, Georgia and parts of Tennessee and North Carolina, which territory was formerly covered by the Middletown district office.

The Edward G. Budd Manufacturing Company, Philadelphia, Pa., in connection with the construction of light weight high speed trains and other units has built special dies, jigs, tools, welding equipment, etc. This equipment is installed in one of its large buildings in the Philadelphia plant which has been rebuilt for straight line production with two tracks running down through its center, with the necessary wells and pits. These tracks connect with the yard where ample rail storage facilities are being provided also with both the Pennsylvania and the main line of the Reading. Three trains are under construction—one for the Chicago, Burlington & Quincy and two for the Boston & Maine. The company now employs over 1500 men on three shifts.

F. R. Kohnstamm has been appointed manager of the Lighting division of the Westinghouse Electric & Manufacturing Company. In his new position, he will have supervision over all lighting activities,

F. R. Kohnstamm

including sales, engineering and manufacturing, now conducted at the Westinghouse Cleveland Works, in Edgewater Park, Ohio. Mr. Kohnstamm, a native of Scranton, Pa., has been associated with the Westinghouse Company since 1917. He was located in East Pittsburgh for the first two years of his service. In 1919 he was transferred to Mansfield, Ohio, where new headquarters for the company's merchandising department had been established. In 1922 he was made manager of the appliance division of this department. Five years later, in 1927, he was appointed assistant sales manager of the same department and, in 1931, he became director of merchandise. Early in 1933, he returned to the East Pittsburgh, Pa., headquarters of the company as sales promotion manager. He held that position until his present appointment and transfer to Cleveland.

Whitley B. Moore has been appointed general manager of the Industrial division of the Timken Roller Bearing Company, Canton, Ohio. Mr. Moore was graduated from the University of Michigan in 1918, going immediately into service in the U. S. Navy. At the close of the war, he joined the engineering staff of The Timken Roller Bearing Company. In 1921, Mr. Moore was transferred to the Pacific coast in charge of sales in that territory. In 1924 he returned to Canton as assistant general sales manager of the Industrial division and since 1930 was sales manager.

L. M. Klinedinst, vice-president in charge of all industrial sales of the Timken Roller Bearing Company, Canton, Ohio, has been elected to the board and also promoted to the office of vice-president in charge of sales, to fill the vacancy created by the recent resignation of Judd W. Spray. T. V. Buckwalter, who has been vice-president of the Timken Roller Bearing Company for several years, has been elected vice-president and director of the Timken Steel & Tube Company. Mr. Klinedinst has been associated with the Timken Company since leaving school 29 years ago. After serving in various junior executive positions in both the manufacturing and selling divisions he was identified with automotive development work for many years, serving as assistant sales manager. In 1921 he was appointed general manager of the Industrial division, and since 1930 has been vice-president in charge of all industrial sales.

Fred W. Venton, assistant manager of the railroad sales department of the Crane Company, Chicago, has been promoted to manager of that department, with the same headquarters. He was born in Cleveland, Ohio, on November 14, 1881, and was educated at Armour Institute of Technology, Chicago. During the early part of his

Fred W. Venton

career he was employed in the shops of the L. H. Prentice Company, and the Chicago, Burlington & Quincy, while later he served as chief engineer of several hotels in Chicago and of the McClintock estate. In 1910, he entered the employ of the Crane Company as traveling engineer and in 1915 was promoted to assistant manager of the railroad sales department.

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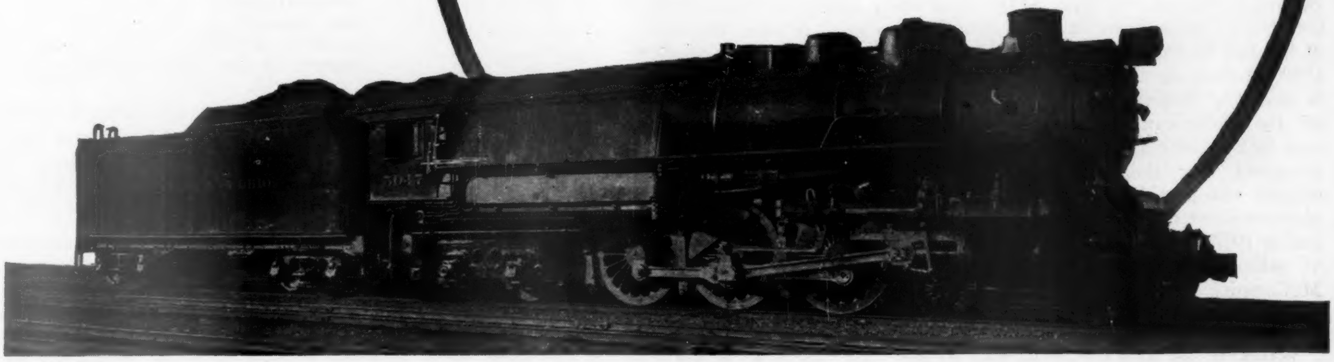
THE BOOSTER *is an Invaluable AND Integral Part of the Locomotive*



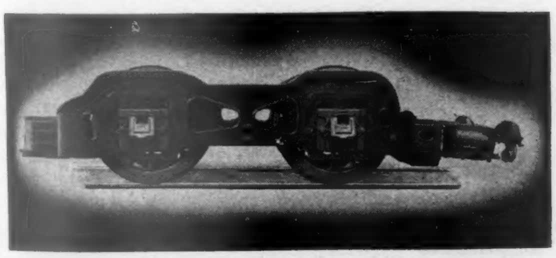
The higher the efficiency with which a locomotive operates over a division the greater the return on the investment and the greater the net earnings.

Booster-equipped, to aid in starting, accelerating and over the ruling grades, the locomotive can produce more ton-miles-per-hour, or, a smaller locomotive can produce the same ton-miles-per-hour.

This permits operating the locomotive at more nearly its maximum efficiency a greater part of the time than would be possible if the maximum demand for power had to be provided by the two larger main cylinders.

In the design of new locomotives the Booster is as essentially an integral part of the locomotive as the main cylinders and driving wheels.

By incorporating the Booster in the original design it permits of a lighter, lower cost locomotive that will be more economical both to operate and to maintain.



No locomotive device is better than the replacement part used for maintenance.
Genuine Franklin repair parts assure accuracy of fit and reliability of performance.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

Obituary

Harry U. Morton, president of the Morton Manufacturing Company, Chicago, died in that city on November 11. He had been inactive in company affairs for two years due to ill health. For 18 years before the organization of his own company in 1913, Mr. Morton had been associated with the Pullman Company.

Lewis W. Metzger, formerly in charge of estimating and accounting work and assistant to the vice-president in charge of sales of the Baldwin Locomotive Works, Philadelphia, Pa., died on November 13 at his home in Mount Airy, a suburb of Philadelphia, at the age of 79. Mr. Metzger had retired five years ago after a service of over half a century with the Baldwin company.

Edward McCormick, who, prior to November, 1931, had been vice-president in charge of sales of the Railway Steel-Spring Company, at New York, died on October 27 at his home in Brooklyn, N. Y., at the age of 58. Mr. McCormick, who in 1919 was treasurer of this company, which is now the Railway Steel-Spring division of the American Locomotive Company, was in that year appointed assistant to the president and the following year was elected vice-president. He first served as vice-president in charge of financial affairs and in 1927 became vice-president in charge of sales. At the time of his death Mr. McCormick was head of a bond brokerage firm under his name in Brooklyn.

William W. Darrow, president of the Camel Company, Chicago, died on November 18, at Philadelphia, Pa., where he had gone on a business trip. Mr. Darrow was stricken with a heart attack on November

William W. Darrow

14, and was taken to the Temple University hospital in Philadelphia, where he died. Mr. Darrow was born on August 29, 1882, at Janesville, Wis., and graduated from the Chicago high schools. His entire business career was spent in the service of the Camel Company. He went with the company in 1901, and five years later was advanced to secretary. In 1915 he was appointed vice-president, and in 1923 was elected to the presidency. Mr. Darrow was also president of the Camel Sales Company.

Personal Mention

General

D. K. Chase, master mechanic of the Pittsburgh-Conemaugh-Monongahela division of the Pennsylvania, has been appointed superintendent of the Toledo division with headquarters at Toledo, Ohio.

Master Mechanics and Road Foreman

H. T. Cover, assistant master mechanic of the Pennsylvania at Wilmington, Del., has been appointed master mechanic of the Buffalo division.

L. W. Miller has been appointed master mechanic of the Port Huron & Detroit, with headquarters at Port Huron, Mich., to succeed James W. North.

H. J. Kleine, assistant enginehouse foreman of the Pennsylvania, has been appointed assistant master mechanic, with headquarters at Wilmington, Del.

Walter Budwell, general foreman of the Shaffers Crossing shop, of the Norfolk & Western, at Roanoke, Va., has been promoted to the position of master mechanic of the Norfolk division, with headquarters at Crewe, Va., succeeding W. J. Yingling, deceased.

Shop and Enginehouse

A. L. Brown, enginehouse foreman of the Norfolk & Western at Bluefield, W. Va., has been transferred to the position of enginehouse foreman at Crewe, Va.

R. J. Barry, assistant enginehouse foreman of the Norfolk & Western at Shaffer's Crossing, Va., has been promoted to the position of enginehouse foreman.

Roy Gable, enginehouse foreman of the Norfolk & Western at Shaffer's Crossing, Va., has been transferred to the position of assistant enginehouse foreman at Portsmouth, Ohio.

L. E. Berry, assistant enginehouse foreman of the Norfolk & Western at Portsmouth, Ohio, has been promoted to the position of enginehouse foreman, with headquarters at Bluefield, W. Va.

C. M. Pettrey, enginehouse foreman of the Norfolk & Western at Crewe, Va., has been promoted to the position of general foreman, with headquarters at Shaffer's Crossing, Va.

Obituary

William J. Given, division storekeeper on the Mobile & Ohio, with headquarters at Jackson, Tenn., died on October 29 at his home at Jackson.

William C. Lang, master car builder of the Pittsburgh & Lake Erie, at McKees Rocks, Pa., was killed in an automobile accident on October 27. Mr. Lang was born on January 5, 1881, and in April, 1903, entered the service of the Pittsburgh & Lake Erie as a clerk at McKees Rocks. He became gang foreman in January, 1905, and was appointed assistant general foreman of car service in November, 1908. In August, 1915, he was appointed general car inspector at McKees Rocks, becoming pilot chief of the Electric division at Grand Central terminal for the New York Central in July, 1918. The following month he returned to the Pittsburgh & Lake Erie as general car inspector at McKees Rocks and subsequently became master car builder.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Linde Products.—"Recommended Practices for Gas Cutting of Structural Steel" and "Precautions and Safe Practices" are the titles of booklets recently issued by the Linde Air Products Company, New York.

Milburn Equipment.—Oxy-acetylene apparatus, cutting and welding tips, paint-spray equipment and portable carbide lights are among the listings in the 1934-35 catalog of the Alexander Milburn Company, 1416 W. Baltimore street, Baltimore, Md.

Alloy-Steel Boiler Plate.—Specifications for chrome-manganese silicon alloy steel boiler plate are given in the reprint from the 1934 addenda to Material Specifications Section, A.S.M.E. Boiler Construction Code, being issued by the Lukens Steel Company, Coatesville, Pa.

Universal Turret Lathes.—A new line of Ram type universal turret lathes is described in the 32-page catalog issued by the Jones & Lamson Machine Company, Springfield, Vt. Complete specifications, photographs and line cuts of the tools, with dimensions, are included in the catalog.

Sheet Iron.—The fifth edition of "Sheet Iron—A Primer," issued by the Republic Steel Corporation, Massillon, Ohio, contains 64 illustrated pages, which tell, in simple, non-technical language, the step-by-step story of modern manufacture of sheet iron. Production is traced from the ore mine to the final inspection of the completed sheet. The booklet also contains gage tables and a glossary of metallurgical terms.

Motive Power Batteries.—Bulletin No. 952, published by the Gould Storage Battery Corporation, Depew, N. Y., describes and classifies Gould armored Kathanode storage batteries, made for use on Diesel and gas-electric locomotives, articulated trains and motor cars. Tables are given for the various types of cells, which show capacity, charging rates, overall dimensions and weights. A feature of the bulletin is a graphical method for determining required battery capacity.

Railway Mechanical Engineer

December, 1934

FOUNDED IN 1832

VOL. 108 No. 12

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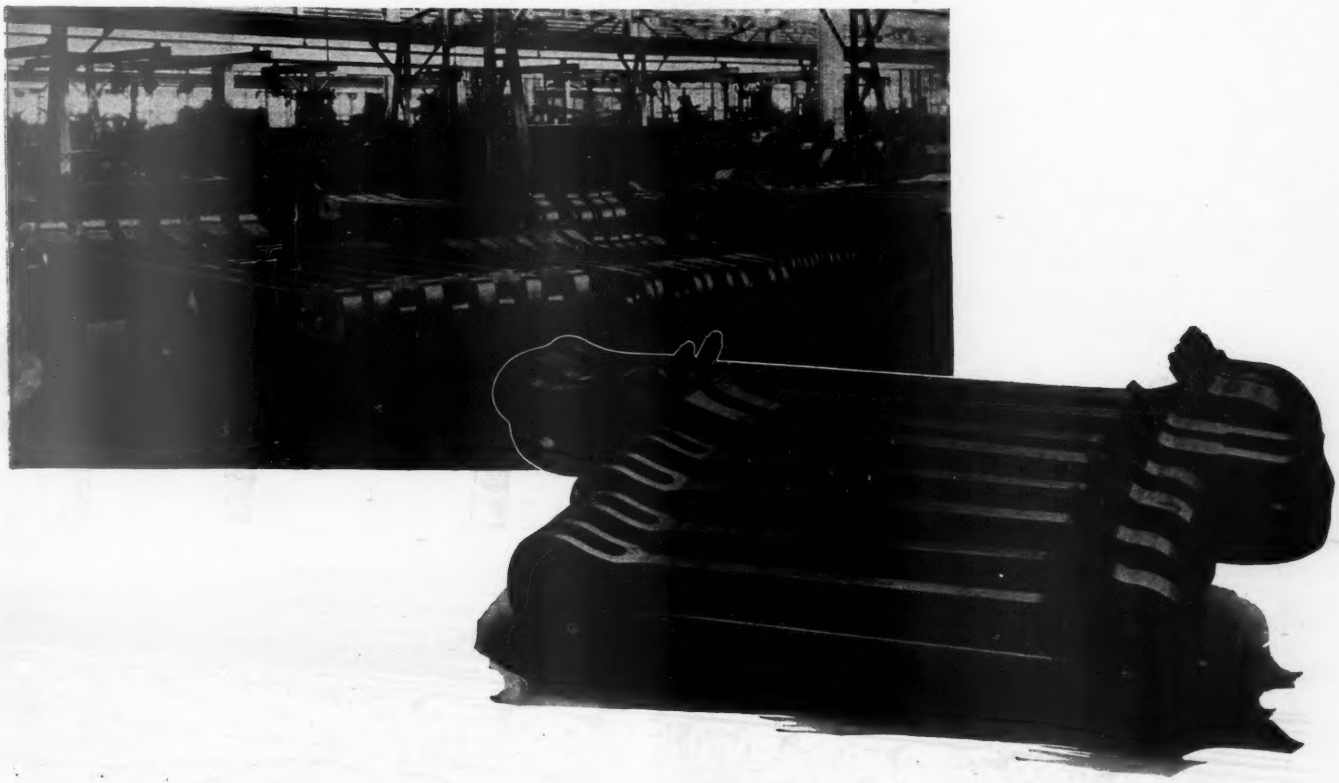
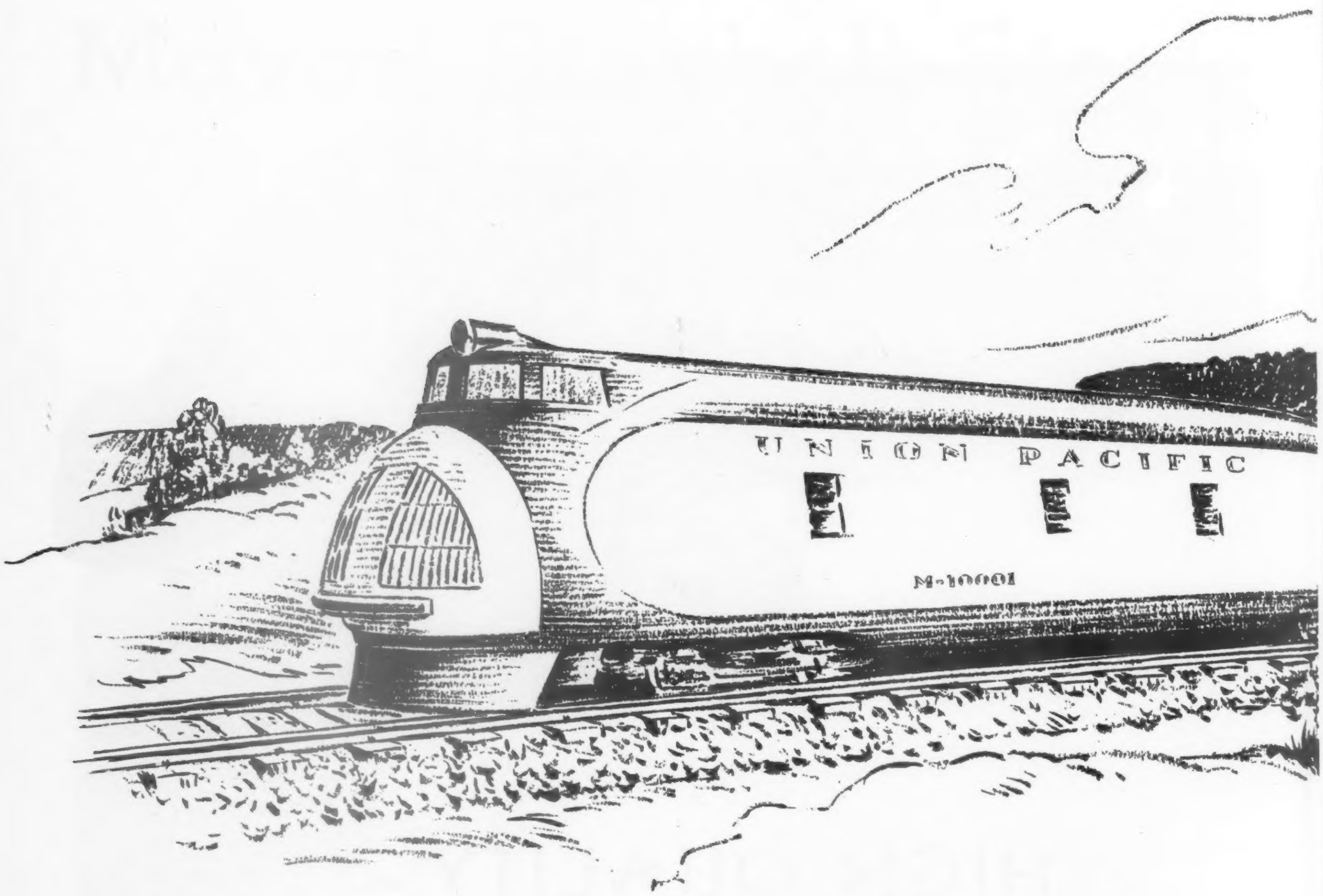




POWERED with GENERAL UNION PACIFIC STREAMLINER

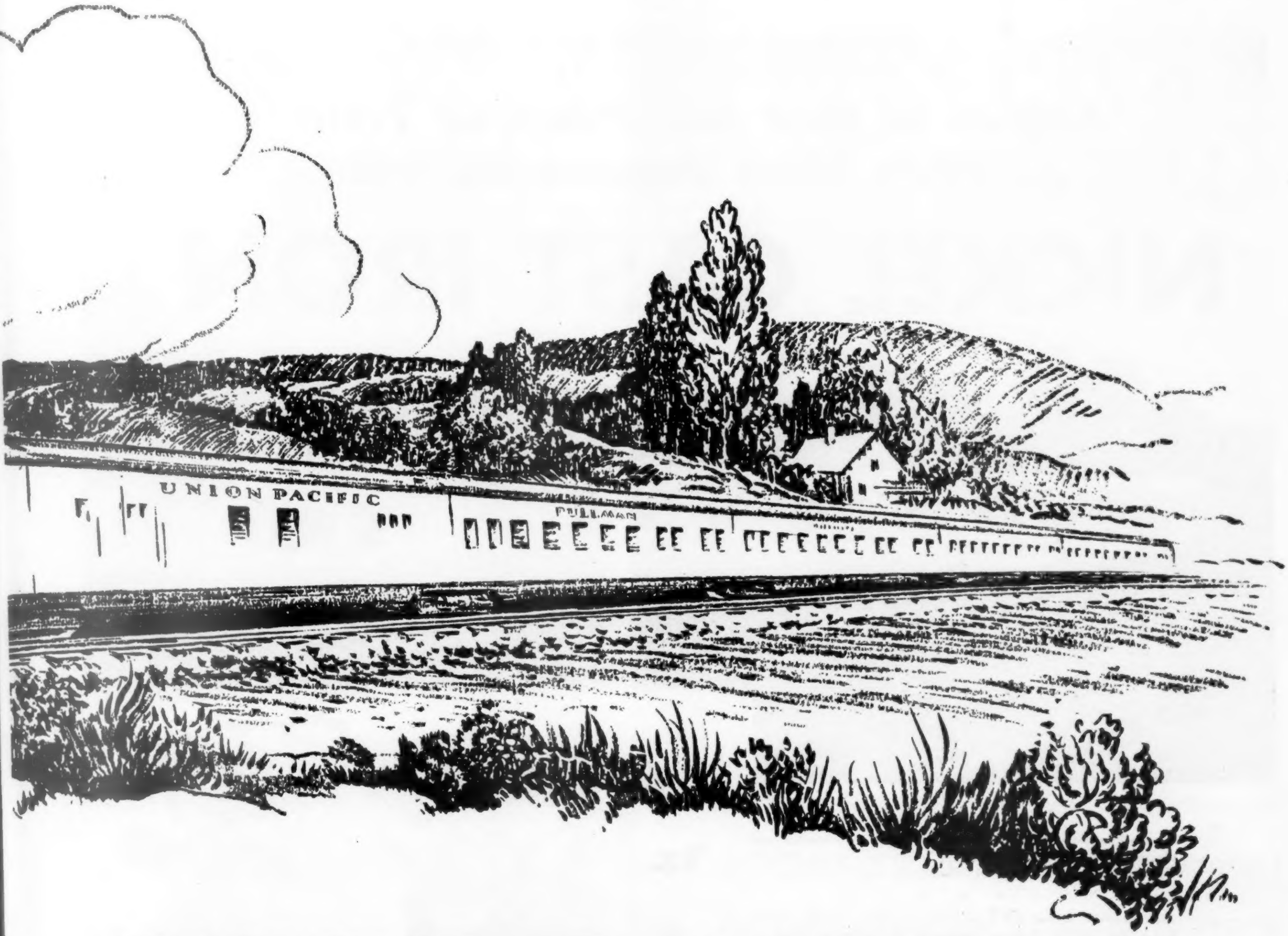
ANOTHER PROOF

THE new Union Pacific 6-car, 900-hp. Streamliner, built by Pullman, equipped with General Electric drive, and powered by a Winton Diesel engine, has set new records of speed and of transportation economy for all parts of the country. On its record-breaking coast-to-coast run, this train averaged 57.2 miles an hour, including all stops. Leaving San Bernardino, it maintained 20 mph. up a 23-mile 2.2-per-cent grade. On the plains of Nebraska, it covered two miles in 60 seconds.

In the 3258-mile run across country, the fuel consumption was 2075 gallons of fuel oil, costing a total of $83. This included oil burned for heating the train.

The train performed perfectly during the entire run, and when it reached New York a complete check of the power plant—engine, generators, motors, control, and compressors—proved everything to be in excellent condition. Not even adjustments were necessary before the train started back on its exhibition tour.

GENERAL


UNION PACIFIC
PULLMAN

SCRAP THEM!

METHODS for the economical scrapping of locomotives and other rolling stock have been developed by The Oxweld Railroad Service Company. These practices have proved money-saving and sound in wide experience on many systems. Oxweld contract roads planning replacement of present equipment should take full advantage of the information and instruction on scrapping by oxy-acetylene cutting now available to them from this source.

The majority of the Class I railroads of the country have been customers of the Oxweld Railroad Service Company for many years and continue to renew their patronage.

THE OXWELD RAILROAD SERVICE COMPANY

Unit of Union Carbide and Carbon Corporation

NEW YORK: Carbide and Carbon Bldg. CHICAGO: Carbide and Carbon Bldg.

Positions Open — **GET TOGETHER DEPARTMENT** — **Positions Wanted**

Classified Advertisements—Help and Situation Wanted advertisements appearing in the "Get Together Department," 10c. a word an insertion. Minimum charge $2.00 for each insertion. For Sale advertisements $10.00 a column inch. Any number of inches may be used. Copy must be in this office by the 10th of each month preceding to insure insertion in the issue.

THE EDITOR'S DESK

WHAT OF THE FUTURE?

Congress meets next month. The Administration in various ways has indicated that it will favor legislation which will help strengthen the railways and restore them to a more prosperous condition. The Co-ordinator of Transportation, who is charged with the duty of recommending legislation to Congress, has not yet made known his program, but judging from his recent addresses, he will suggest measures of a favorable nature.

What Can Be Done?

The RAILWAY AGE, associated with the RAILWAY MECHANICAL ENGINEER as one of the family of Simmons-Boardman publications, on December 1 published a special number in the interests of securing a square deal for the railways, which promises to rank as one of the most outstanding achievements in the field of business paper journalism. Copies of it will go with individual letters to members of Congress, members of state legislatures, and to important governmental and transportation regulating authorities, etc.

Specifically what does it suggest?

National Recovery Depends on Durable Goods Industries

First, it demonstrates the importance of the durable goods industries to re-employment and to national recovery. It proves also that the railways, when prosperous, are one of the largest and most important purchasers of durable goods, these purchases directly affecting every part of the nation.

Railway Purchases Depend on Railway Net Earnings

The volume of railway purchases depends upon net earnings. After clearly demonstrating this, a survey is made of the ways and means by which earnings can be increased. These include a reasonable regulation of the railways' competitors and the elimination of subsidies which have been given to them; the proposed increase in freight rates; improvements in service which will enable the railways to compete more effectively with other common carriers; and possibilities of further operating economies. Then, also, the importance of credit is emphasized as a factor in increased buying by the railroads.

What the Railroads Want to Buy

The needs of the railways for materials, equipment and supplies are analyzed, special attention being given to prospective expenditures on rolling stock and shops. Here, as in other articles, attention is focused upon "steadily accumulating unrestored deterioration." In concluding this particular article, the statement is also made that "during the four years of the depression there has been a general suspension of the purchase of motive power, rolling stock and shop machinery. During this period new materials of construction, better designs and new conceptions of service have accelerated the growth of obsolescence of existing equipment. That the railways are alive to the importance of these developments and will take full advantage of them, when earnings permit the serious consideration of major expenditures on capital account, is evident from the attitude toward air conditioning and the disposition to undertake trials of new forms of equipment, even during the depression."

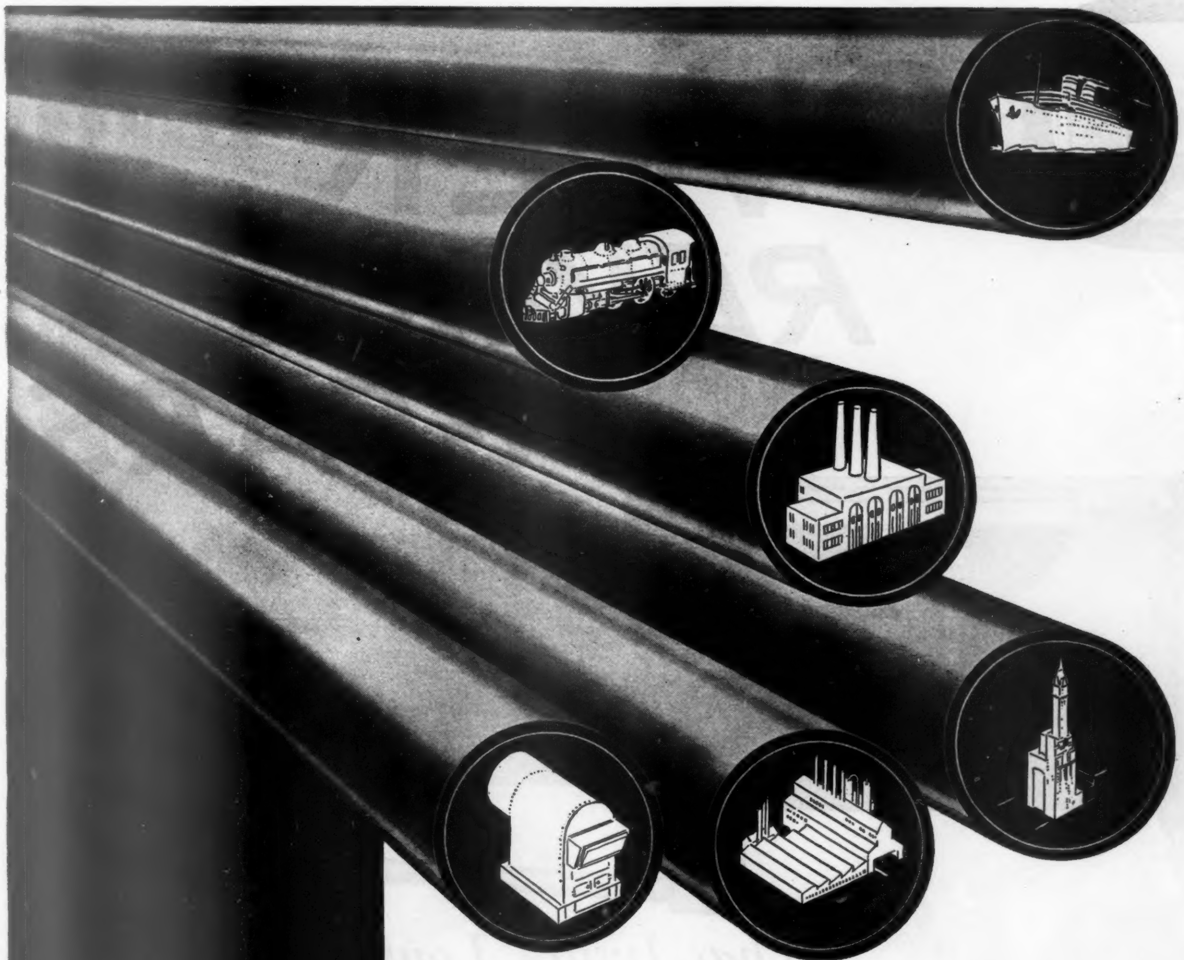
Other Factors in the Problem

There are, of course, other important factors involved in the solution of the transportation problem. The railways, for instance, are handicapped by the use of cheap labor by the highway and waterway carriers. Then there is the question of grade elimination and its bearing on the unemployment problem.

What WE Can Do to Help!

Use every bit of influence you and your friends may have to bring these facts home to those who are responsible for making laws — *state and federal.* Every one of us can bring some influence to bear upon our local representatives. We are not asking for special privilege or charity. All we want is a "Fair and Square Deal."

Roy V. Wright



North or South, East or West,—wherever you may be during the holiday season, we again send you greetings from the home of the Wyandotte Indian. May the New Year bring you a fuller share of contentment and prosperity and as much genuine pleasure in all your business relationships as we have felt in our relationship with you!

The J. B. Ford Company

Wyandotte, Michigan

Wyandotte
PRODUCTS

INDEX TO ADVERTISERS

DECEMBER, 1934